

MODULE (OVERVIEW)

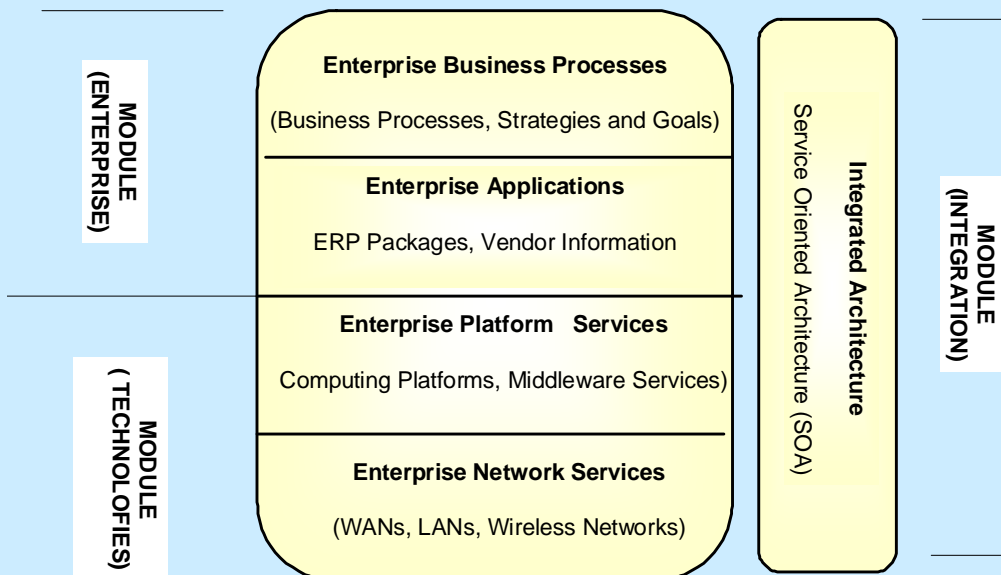
The Big Picture

Suppose you are part of a team that has been given the responsibility of developing an overall vision of a globally distributed but US-based retail store. The company has offices and partners in England, Turkey, Singapore and China. Specifically, your team has been asked to develop a business strategy plus a technical solution that will double its business in three years. This raises questions such as the following:

- Where to start
- What are the business issues
- What type of business partnerships will be needed
- What are the key enabling technologies needed to support the business initiatives
- How do the business and technology building blocks fit into an enterprise architecture
- What methodology can be used to systematically make all decisions

These questions, and others of this nature, are difficult to answer. This chapter attempts to answer these questions by painting the big picture based on enterprise architectures and integration.

The discussion is guided through a conceptual framework, shown below, that shows several broad building blocks: business processes, applications that support the business processes, and the IT infrastructure to enable the applications. The framework also establishes the interrelationships between these building blocks and serves as a roadmap for this book. Specifically, different modules of this book (Enterprise Module, Technologies Module, and Integration Module) cover different aspects of this framework. An overall methodology and a computer aided toolset is also presented and illustrated through an example. .



1 Enterprise Architectures and Integration -- The Big Picture

1.1	INTRODUCTION	1-2
1.2	STARTING POINT -- ENTERPRISE MODELS AND FRAMEWORKS	1-4
1.3	ENTERPRISE ARCHITECTURE AND INTEGRATION CONCEPTS	1-8
1.3.1	<i>What is an Architecture?</i>	1-8
1.3.2	<i>What is an Enterprise Architecture and Why is it Important?</i>	1-9
1.3.3	<i>From Enterprise Architectures to Enterprise Integration</i>	1-12
1.3.4	<i>Enterprise Architectures and Integration -- A Closer Look</i>	1-15
1.3.5	<i>An Example -- Frank's Furniture Store (FFS)</i>	1-17
1.4	ENTERPRISE ARCHITECTURES AND INTEGRATION THROUGH SOA	1-21
1.4.1	<i>A Service Oriented View of Business</i>	1-21
1.4.2	<i>Service Oriented Architecture (SOA) at a Glance</i>	1-23
1.4.3	<i>How SOA Can be Used in EA (Enterprise Architectures)</i>	1-24
1.5	HIGH LEVEL METHODOLOGY FOR INTEGRATED ENTERPRISE-WIDE ARCHITECTURES .	1-26
1.5.1	<i>Overview</i>	1-26
1.5.2	<i>Enterprise Focus Stages</i>	1-28
1.5.3	<i>IT Infrastructure Focus Stages</i>	1-31
1.5.4	<i>Integrated Architecture Focus Stages</i>	1-33
1.6	PISA-AIM -- A COMPUTER AIDED TOOLSET FOR ARCHITECTURE AND INTEGRATION.	1-37
1.6.1	<i>Overview of PISA (Planning, Integration, Security & Administration) Environment</i>	1-37
1.6.2	<i>Quick Tour of PISA Environment -- An Example</i>	1-39
1.7	THE BOOK ROADMAP	1-46
1.7.1	<i>Book Outline</i>	1-46
1.7.2	<i>How PISA Can be Used to Support this Book</i>	1-48
1.8	A CASE STUDY: INTRODUCING XYZCORP	1-49
1.9	SUMMARY	1-51
1.10	REVIEW QUESTIONS AND EXERCISES	1-51

1.1 Introduction

Enterprises in this global economy represent networks of autonomous firms cooperating with each other to achieve common business goals. In this climate, a firm's supply, production, logistics and distribution networks need to be architected in an integrated and flexible fashion to quickly respond to fluctuating market conditions and frequent mergers, acquisitions, and outsourcing operations. To survive and thrive in this rapidly changing environment, modern enterprises need to establish flexible enterprise-wide architectures that can quickly integrate and deliver needed services. For example, when a manufacturing company acquires multiple companies with widely varying systems based on different technologies of different vintages, an enterprise wide architecture is needed that makes the acquired and the existing systems work smoothly with each other.

Enterprise architecture (EA) and more importantly an integrated enterprise architecture (IEA) is a key tool for competitive advantage because it smoothly inter-weaves the IT operations with the organizational business strategy. In addition, it is important to show how an IEA can be developed effectively, instead of just preaching that it needs to be done. This chapter establishes the underlying principles of enterprise architecture (EA), the importance of integration in EA, and the role that service oriented architecture (SOA) can play in developing an integrated enterprise architecture. In addition, a systematic methodology is proposed that can be used in practice to develop IEAs. Finally, a computer aided IT planning, integration, security and administration (PISA) toolset is introduced to support the methodology.

The objective of this chapter is to give a broad overview of the subject matter and to set the tone of this book by answering the following questions:


- What is the basic EA framework that ties business strategies to the applications and the enabling IT infrastructure (Section 1.2)?
- What are the main ideas of enterprise architecture and integration and how do they lead to an integrated enterprise architecture (Section 1.3)?
- What is service oriented architecture (SOA) and how does it help in the development of an integrated enterprise architecture (Section 1.4)?
- Can a methodology be crafted that could systematically lead the users through the various decisions (Section 1.5)?
- How can a toolset such as PISA be used to develop IEAs (Section 1.6)?

This chapter establishes a framework for discussion and introduces many ideas and concepts that are explained in more detail in the later chapters.

Chapter Highlights

- Business strategies, applications, and IT infrastructure are the three essential components of an enterprise
- An enterprise architecture (EA) shows components of an enterprise, what do they do, and how do they interface/interact with each other
- Enterprise architecture (EA) = Business architecture + application architecture + technology architecture (computer platform architecture + network architecture)
- Integrated enterprise architecture (IEA) = EA with focus on integration. Integrated enterprise architecture provides an inventory of the business and IT resources and how they work with each other smoothly and seamlessly (hopefully!).
- IEA promises many benefits that include: identifying what resources exist; improving integration among resources; facilitating business process improvement, and creating speed and efficiency in meeting changing business needs through IT.
- SOA is an effective way to develop an IEA. SOA provides a standards-based conceptual framework for flexible and adaptable enterprise wide systems.
- A high level methodology is very useful in developing an IEA. The methodology presented in this chapter consists of individual plans that can be developed and then integrated together into an enterprise wide architecture.

Automated tools are of essential for day-to-day use of a methodology. A practice-based tool, called PISA (Planning, Integration, Security and Administration) environment supports the IEA methodology through a family of intelligent consultants (advisors), integrated around an extensive knowledgebase. The PISA advisors build different parts of the architecture and then allow the company to compose a comprehensive IEA from the parts.



The Agenda

- Enterprise Architecture & Integration
- SOA for Integrated EA
- A High Level Methodology
- An Automated Toolset

1.2 Starting Point – Enterprise Models and Frameworks

Modern enterprises have to architect and integrate internal and external systems to survive and thrive in this rapidly fluctuating business landscape. Sound integrated architectures are especially vital to the modern digital enterprises that rely heavily on deep technology stacks to conduct business between widely distributed customers, suppliers, and business partners. Different views of modern enterprises (MEs) have been presented in the literature under varying titles such as enterprise 2.0 [McAfee 2006], mobile corporations [Kalakotta 2002b], extended enterprises [Davis 2003], agile and on-demand enterprises [Cummins 2008, Fellenstein 2004], specialized enterprises [Pohle 2005] and next generation enterprises [Kidd 2000, Umar 2004, Umar 2007]. The main message is that MEs provide a network of specialized services that are offered over a global connectivity platform. Within this broad picture, several types of configurations can be envisioned depending on the usage scenarios, the parties involved (e.g. retailers and end customers as opposed to wholesalers), and a number of other attributes. After experimenting with several conceptual models, we feel that the following four megatrends define a reference multidimensional space for MEs (see Figure 1-1):

- Web (W) reliance of internal as well as external business activities through ebusiness, ecommerce and other “e-initiatives”,
- Mobility (M) support for the mobile customers, workforce and operations
- Dispersion (D) of operations to widely dispersed sites due to outsourcing and rentals, and
- Agility (A) (on-demand services) to quickly respond to changing business conditions.

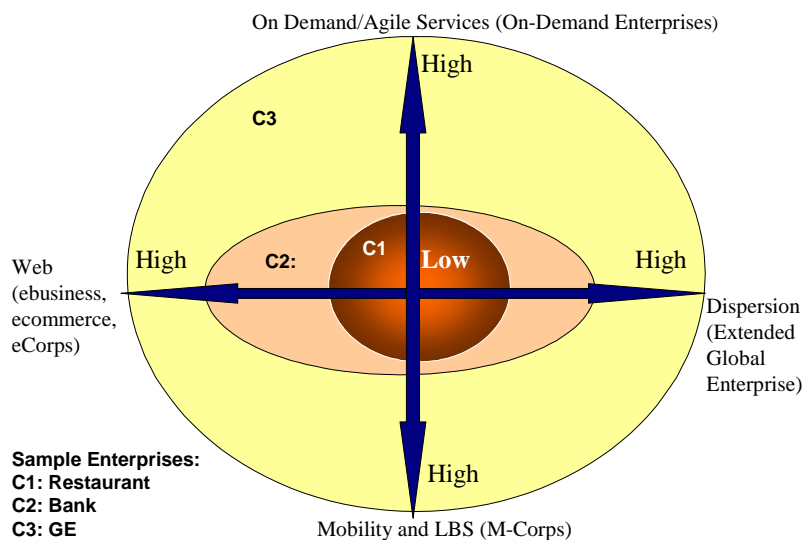


Figure 1-1: Conceptual Model of Modern Digital Enterprises

The main idea is that MEs are not one dimensional entities that are relying on agility or mobility alone but are instead multidimensional enterprises that are *simultaneously* pushing the envelope in all four directions. For example, companies such as Amazon.com and General Electric (GE) are exploiting all four dimensions fully. Different enterprises can be mapped to different regions in this diagram and are represented as circles/ellipses. For each dimension, the {Low, Medium, High} ordering is defined by locating the “easy case” at the center, in such a way that outer regions naturally come to represent more challenging areas. For example, the inner circles shown in the figure indicate traditional enterprises with low reliance on any of these four capabilities while others show extended global enterprises. In Figure 1-2, configuration C1 indicates a sample restaurant with low reliance on all four dimensions, C2 represents instance of a medium sized bank that has low use of mobility and agility but does provide Web banking and fund transfer services with other banks, and C3 exemplifies GE. Different circles/ellipses can also be used to represent evolving strategies of the *same* company. For example, Guess Jeans has evolved over the years from a small inner circle to pushing all four dimensions (see the sidebar “Case Study: How GUESS Jeans Translated Strategies to Working Solutions”).

This simple conceptual framework characterizes the evolving next generation enterprises (NGEs) -- . NGEs lie at the outer edges of this model. As the NGEs push *simultaneously* towards these four dimensions, they dramatically increase their reliance on a complex array of IT (information technology) services and thus create many new challenges. Specifically, an NGE utilizes the next generation of business models (e.g., real-time business management, mobile processes and virtual operations through outsourcing) by fully exploiting and integrating the next generation technologies (e.g., wireless communications, broadband networks, Semantic Web, Web Services, and Service Oriented Architectures) to succeed in the competitive global marketplace.

There are good news and bad news associated with the drive towards NGEs. While these enterprises promise many benefits, they are becoming extremely complex and IT dependent. As this complexity escalates, it becomes harder and harder for IT outsiders to understand what’s being achieved and how it’s helping the organization advance its goals. Thus it becomes more crucial for the organizations to understand what value the increased reliance and expense on IT is providing. This is a major problem. According to a META Group report surveying five hundred Fortune 500 firms between 1998 and 1999, fewer than 25% of the IT projects in these firms met the project goals [Buchanan 2002]. And worse yet, senior managers from the same survey reported that less than 12% of the IT projects “fundamentally advanced the strategic goals of the enterprise”.

To better understand the complex interactions between business and IT and how IT supports the business, a very simple view is presented in Figure 1-3. This view of an enterprise is presented in terms of three high level layers and their role as drivers and enablers of an enterprise:

- Business focused layer that concentrates on business strategies, services and business processes:
- Business plus technology focused layer that deals with enterprise business applications
- Technology focused layer that provides the IT (information technology) infrastructure

Business strategies represent the long range game plan to win in the marketplace. Business strategies align the business products/services, processes, and several other activities to survive and succeed in the marketplace. The term business service and business process are frequently interchanged. For the purpose of this book, we will use the following definitions;

- **Business service (BS)** is something that is delivered to the customer. For example, dry cleaning service, house renovation service and online banking represent things that are delivered to the customer, usually for a fee. A business service may be delivered to internal or external customers. For example, a payroll service is delivered to the employees of a company. Businesses usually deliver products, services or both to its customers.

- **Business process (BP)** is a collection of *activities* that are required to achieve a business goal – the goal may be a business service. At a basic level, a BP can be represented as a flowchart that specifies the orchestration of activities needed to complete the goal. For example, for a payroll *service*, several BPs have to be carried out (e.g., pay has to be computed, deductions have to be considered, overtime may need to be calculated, etc).

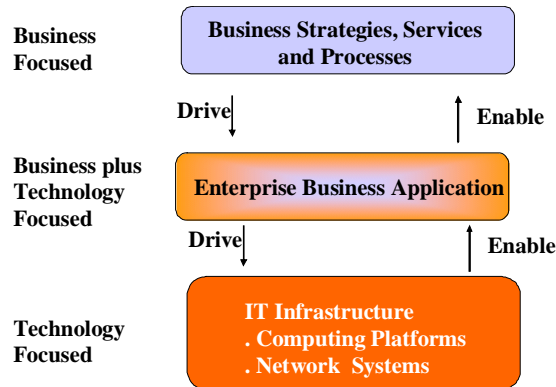


Figure 1-3: Key Components of an Enterprise

Thus a business service specifies what a user *receives* while a business process shows *how* the service is provided. In other words, a business service is an *external view*, while a business process defines the *internal* set of activities and their flows needed to provide a service. In many cases, BPs and BSs can be interchanged. For example, for a higher level service (e.g., customer service), many other BSs may be treated as BPs and combined with other BSs/BPs (e.g., troubleshooting, follow-up, upselling) for customer service. Unless needed, we will use BP or BS to signify the same thing. Business strategies, business services and business processes are an extensive area of business activity and are discussed widely in the traditional business and information systems management literature (see Chapter 2 for details).

Enterprise business applications are the computer-based information systems that provide automated support to the business services/processes. These applications are also referred to as enterprise applications, business applications or just as applications in the literature. Whatever the name, these applications are business aware. For example, an airline reservation system contains business logic and data that is not the same as a hotel reservation system (business awareness). Business applications also provide business value to an enterprise. Obviously, an airline reservation system provides business value to the airline business. These applications use information technologies to support the enterprise and thus are enablers to the business processes.

Modern enterprises use applications such as marketing support systems, automated order processing and tracking systems, e-commerce systems, telecommunications provisioning systems, and real-time manufacturing control systems. These applications consist of a user database (a pool of data), a set of programs to access and manipulate the database, and user interfaces to invoke the programs. A business application may also be centralized (all of its components at one site) or distributed (its components reside at different computers on a network). A business application may work within an organization (*Business To Employee -- B2E -- Applications*), support external customers (*Business to Customer --B2C -- Applications*) or may involve business to business interactions (*Business to Business --B2B -- Applications*). eBusiness applications are business applications that support the e-business at B2E, B2C, as well as B2B levels. *ERP (enterprise resource planning) systems* provide a

collection of applications, integrated around a common database. We will discuss enterprise applications and ERP systems in detail in chapters 3 and 4.

The information technology (IT) infrastructure is used to build, deploy and operate the business applications. IT infrastructure, also sometimes known as computer-communication platform, consists of technologies such as computers, operating systems, networks, databases, and transaction managers. *This infrastructure enables the applications and is business unaware.* For example, the same type of networks and computers are used in airline reservation systems as well as hotel reservation systems. The best known infrastructure is the network that interconnects remote applications, databases, and users. Internet, wireless, and broadband networks are examples of vital network technologies.

An important player in modern enterprises is *middleware*, an increasingly crucial and, at the same time, bewildering component of the modern IT infrastructure. Middleware is needed to interconnect and support applications and users across a network. Middleware services typically include directories, emails, and facilities to invoke software to access and manipulate remotely located databases and applications. Middleware services are typically provided by specialized software packages (for example Lotus Notes is a middleware package that supports groupware applications). However, middleware services may be implemented in a combination of database management systems, computer operating systems, and transaction management systems. Web technologies are the most commonly known example of middleware services. Middleware and Web technologies are explained in great detail in chapters 5 through 8 of this book.

As we will see, the simple but elegant view presented in Figure 1-4 will lead us to the following starter definition of an Enterprise Architectures:

Enterprise architecture (EA) = Business architecture + application architecture + technology architecture (computer platform architecture + network architecture)

CASE Study: How GUESS Jeans Translates Strategies to Working Solutions

GUESS Jeans dominated the designer jeans and casual clothing market during the 1980s and early 1990s. But by 1997 the company had evolved into a large corporation that was difficult to manage and was having to compete with Levi's and the Gap for market share. Paul Marciano, the company's co-chair and co-chief executive officer, set an ambitious sales target to triple sales to \$2 billion by 2003. He also turned to IT to help him keep costs low while increasing sales. Over the years, GUESS Jeans has competed in the marketplace by pushing the four dimensions (web, mobility, distribution, and agility) of the enterprise model presented in Figure 1-5 and by providing the needed business services/processes, enterprise applications and the IT infrastructure shown in Figure 1-3.

To accomplish its goal of tripling its sale, GUESS launched several major projects. In addition, GUESS used the help of software vendors PeopleSoft and CommerceOne to create a B2B Buying Network for its suppliers and independent retailers in the United States and many other countries. The suppliers/retailers could order merchandise directly from a B2B Web site called ApparelBuy.com. This online purchasing system is integrated with GUESS's core order processing systems, thus the customers can track their orders through fulfillment or delivery any time of the day or night. The ApparelBuy.com system maintains an on-line catalog and integrates information from sales, inventory, and other

business functions. ApparelBuy.com can detect order errors by checking catalog product numbers, correct the orders, and avoid shipping the wrong products, thus cutting down the number of returns. To support these enterprise applications, GUESS invested heavily in Web technologies and replaced its outdated network with up-to-date network technology, working with Cisco Systems. With new systems in place, GUESS reduced its ordering process to one or two days, as compared to one to two weeks to place and receive orders using manual processes.

Specifically, GUESS maintains a C2B Website for retail customers, called GUESS.com, which offers product catalogs and the ability to order merchandise on-line. GUESS also established BabyGuess.com and GuessKids.com as e-commerce sites for retailing infants' and children's clothing and accessories. These sites generate as many sales as one of the GUESS walk-in stores. GUESS is also streamlining its internal business operations by using Internet and Web technology. The company has established GUESSExpress as an internal private network (Intranet) that is used for exchanging messages between managers and employees, reviewing industry trends, purchasing supplies, reviewing plans for new stores, making travel arrangements, and access to employee benefits records.

GUESS management is relying on IT to change how the company conducts business in the twenty-first century. The new systems have replaced most of GUESS's telephone and fax-based processes. Management believes these systems will continue to increase revenue and decrease costs by providing more sales channels, improving supply chain management, and reducing administrative expenses.

Sources:

- Laudon, K., and Laudon, J., "Management Information Systems", 7th edition, Prentice Hall, 2002
- Thomas York, "Perfect Fit," Cisco IQ Magazine, January/February 2001
- www.Guess.com (viewed, December 30, 2008).

1.3 Enterprise Architecture and Integration Concepts

1.3.1 What is an Architecture?

Architectures play a vital role in modern information systems because they show how the individual systems tie together to satisfy the overall requirements. Many views on architectures exist at present (see, for example, [Askit 2001, Caruso & Umar 2003, Clemens 2002, Herzum 2000]). It is not our objective to give a comprehensive discussion and comparison of architecture definitions (see the sidebar "Architectures: Glossary and Definitions"). Instead, we adopt the following simple but highly operational definition of architecture:

Definition: An architecture of a system is a structure that describes three things:

- Components of the system (what are the pieces of a system?),
- Functions performed by the components (what do they do?), and
- Interfaces/interactions between the components (how do they work with each other?).

This definition is consistent with the IEEE 610.2 definition of an architecture: "The structure of the components, their properties, relationships, and the principles and guidelines governing their design and evolution over time."

Within the context of information systems, several types of architectures have emerged over the years (e.g., business architectures, database architectures, computing architectures, network architectures, software architectures). In all of these cases, it is useful to remember what are the components of the system, what they do, and how they interface/interact with each other. For example, a business architecture would show the business components (e.g., the business processes), what they do (e.g., satisfy customer needs) and how they interface/interact with each other.

Architectures: Glossary and Definitions

Building Construction Architectures: The structural abstractions (e.g., blueprint) and styles (families of related common variations) that define a class of structure (e.g., a cathedral) or a particular structure (e.g., my house). Architecture usually focuses on the big picture and not the details of what color my rug is or specific pictures on my wall, though such details can be viewed as architectural since they could be consonant or dissonant with the architecture's theme. There is no clear dividing line.

Application Architectures: Application architectures are broad architectures of the domain/application of interest and, more narrowly, sometimes application generators for specific domains.

Software Architecture: A static framework or skeleton (structure or set of conventions) that provides the form of a software system and the conventions, policies, and mechanisms for composing itself with subsystems, or component parts, that can populate the architecture. The architecture defines how the parts relate to each other including constraints governing how they can relate. An abstract framework is one that has not been instantiated with specific subsystems.

Other Glossaries:

- Gio Wiederhold's glossary of I3 architecture terms (www-db.stanford.edu/gio/1996/glossary.ps).
- DoD DISA terminology (www.disa.mil/disasub.html).
- NIIIP Reference Architecture: Concepts and Guidelines - Glossary (www.niiip.org/public-forum/ntr86-010html/Rashort-8.html).

Source: Craig Thompson and Frank Manola, "Component Software Glossary", www.objs.com, Glossary sponsored by the Defense Advanced Research Projects Agency and managed by the U.S. Army Research Laboratory under contract DAAL01-95-C-0112. 1997

1.3.2 What is an Enterprise Architecture and Why is it Important? ¹

An enterprise architecture (EA), based on the aforementioned definition of an architecture, shows components of an enterprise, what do they do, and how do they interface/interact with each other. This seems simple enough. However, many different definitions of EA have accumulated since the

¹ This discussion has been greatly influenced by the research paper "Enterprise Architecture Leads to IT ROI and Competitive Advantage" by Jennifer Gronwaldt, Pennsylvania State University- Harrisburg, December 8 2008

1980s. The term ‘enterprise architecture’ was introduced by [Zachman 1987] as a way to *document* the technology attributes of an organization. Modifications and extensions of Zachman’s model have included the Department of Defense Architectural Framework (DoDAF), the Open Group Architectural Framework (TOGAF), the Federal Enterprise Architecture Framework (FEAF), and more [Lindstrom et al. 2006]. In addition, EA is viewed as a ‘process’, as a ‘result’ of the process, and also as a ‘discipline’ that combines both. For example:

- Many practitioners and researchers view EA as a product (e.g., a document). For example, [Shah and El Kourdi 2007] state that an EA documents the organization’s IT assets (people, processes and tools) in alignment with the organization’s strategic business goals. Similarly, [Cardwell 2008] emphasizes that an EA creates an inventory of organizational business units, the business processes therein, and the IT assets required for the processes
- META Group, an IT consultancy which has since merged with Gartner Associates, refers to enterprise architecture as a process, not a product. According to META/Gartner, an EA is “a business vision-driven process that decomposes the enterprise’s business strategies, the assets and processes required to execute them, as well as their impact on business functions It provides IT organizations with a systematic approach to aligning IT projects with corporate goals and priorities” [Buchanan 2002, p.5].
- Chief Technology Officer (CTO) Tony Scott of GM believes that EA is more than a process. He refers to EA as a ‘discipline’ because of the degree to which architects and project managers need to stay dedicated to the architecture in order to reap the benefits [Pastore 2004].

Whatever the definition, EA is a consolidation of business and technology that can be of great value to the corporate management as well as CIOs. Here are some possible values of EA [Cardwell 2008, Koch 2005, Rico 2006]:

- EA aligns IT to business and leads to integration of business and technical processes. Basically, an EA is a road map that presents how all aspects of the IT program are aligned with the organization’s strategic goals.
- Properly executed, “an EA can clarify and help optimize the interdependencies and relationship among an organization’s business operations and the underlying IT infrastructure and applications that support these operations” [Cardwell 2008, pp.49].
- EA facilitates the CIO’s performance and supports the deliverables by the CIO and the IT organization. It provides an explanation of how IT is used to enable the business processes and business strategies.
- Review of EA documents can reveal gaps and duplication and can also support impact analysis. EAs facilitate enterprise planning and problem solving views at different layers (business, applications, and IT infrastructure).
- EAs can be used to document the present method of operation (PMO) as well as the future method of operation (FMO). The differences between PMO and FMO lead to gap analysis and a planning tool about how to ‘get from here to there’.
- EA can be used to evaluate the quality of IT services. return on investment (ROI) from IT can be derived by uncovering where, how well, and for what end IT is being used.
- The process of developing the EA creates opportunities for continuous business process improvement. An EA is developed in a similar manner to how a business process hierarchy is developed, as both are a visualized understanding of the relationship between people, process, information and technology. In some cases, the careful examination of business processes required in developing the EA, leads to the instances when some of the business processes are actually written down.
- Development of an EA presents an opportunity for collaboration between IT and other business functions. It also requires support from the top management -- investment of time and resources plus commitment to the changes inherent to the discoveries resulting from the EA process have to

be authorized. An ideal EA initiative can emerge from the joint support of the CIO and CEO, or other chief operations or financial officers.

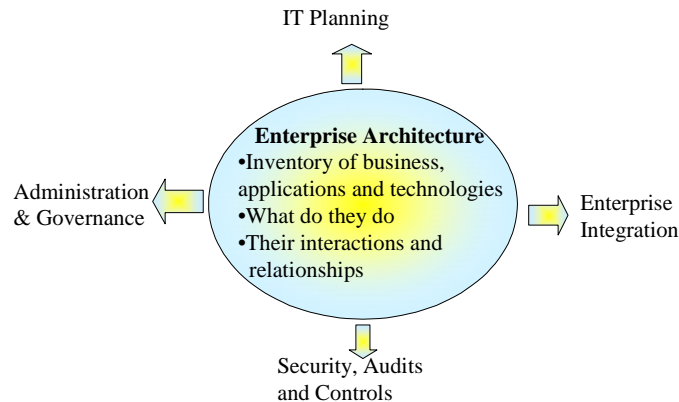


Figure 1-6: Conceptual View of an Enterprise Architecture and its Benefits

Figure 1-6 shows a conceptual view of an EA and its benefits in terms of four broad categories (planning, integration, security, and administration – PISA). This conceptual view is the foundation of the PISA toolset described later. EAs, however, present many challenges to the organization. Development and maintenance of an EA can be a long and expensive undertaking. It is important to measure ROI of an EA effort. For ROI estimates, tangible measurements of the costs and benefits need to be identified. The costs of establishing an EA can be organized into distinct classes such as financial improvement, constituent services, and reduced redundancy. The benefits have been listed above. Monetizing the different types of costs and benefits facilitates the demonstration of ROI. Besides ROI, considerable effort is needed to make sure that the EA efforts are successful. For example, CIOs and CTOs can be removed from the actual development and the use of the EA document, especially in large organizations. In such cases, a group of architects, each focusing on a different dimension, generally report to a chief enterprise architect, who in turn, reports to the CIO

A great deal of information about enterprise architectures is available. Here are some key sources:

- The Open Group Website (<http://www.opengroup.org>)
- Zachman Institute for Framework Architecture (ZIFA) Website: (www.ZIFA.com) ::
- EA Portal at www.enterprise-architecture.info
- Enterprise Architecture Center of Excellence (EACOE) website (<http://eacoe.org>)
- Gartner Group (www.gartner.org) Enterprise Architecture Practice

Case Study: FDA Uses Enterprise Architecture to Standardize and Save

The Food and Drug Administration (FDA) needed to develop a plan for consolidation of its IT infrastructure across eight division centers and identify standard software applications to be utilized for common business needs. The FDA turned to Enterprise Architecture (EA) to serve as the methodology to achieve its desired state of efficiency and effectiveness. FDA maximized its infrastructure by replacing single-use environments with platforms shared across application system boundaries and consolidated IT operations from multiple buildings to two major locations by employing homogenous platform architecture.

EA driven IT consolidation has allowed the FDA to use fewer resources while operating more efficiently and providing better services. Key benefits of this project include: increased cost savings (over \$10 million redundant IT related costs eliminated), documented and standardized business processes (over 85% of agency-wide processes are now documented), consolidation of IT infrastructure resulting in less applications (for example the number of correspondence tracking systems were reduced from 24 to 2), improved communication, and lastly improved decision making.

Source: Federal Enterprise Architecture Program Management Office, Link: http://www.whitehouse.gov/omb/egov/documents/FDA_FINAL.pdf

Benefits of Enterprise Architectures – Views of a CTO

In a 2004 article for the Zachman Institute for Framework Advancement (ZIFA), General Motors CTO Tony Brown, lists the reasons below as what he considers to be the top advantages of implementing EA:

- Readily available documentation of the enterprise
- Ability to unify and integrate business process across the enterprise
- Ability to unify and integrate data across the enterprise and to link with external partners
- Increased agility by lowering the ‘complexity barrier’
- Reduced solution delivery time and development costs by maximizing reuse of enterprise models
- Ability to create and maintain a common vision of the future by both the business and IT communities driving continuous business/IT alignment

Source: [Cardwell 2006]

1.3.3 From Enterprise Architectures to Enterprise Integration

Development and maintenance of an EA, as suggested so far, is a worthwhile effort. However, how does it impact *enterprise integration* – an area of particular interest in the competitive marketplace. Most organizations are struggling to integrate their systems to maintain a competitive edge. The drive for enterprise wide integration is not new. Mergers and acquisitions, for example, introduce numerous scenarios when systems from one company need to mesh with the systems of the new corporate "friends". However, as the enterprises move towards the outer edges of the enterprise model shown previously in Figure 1-1, the lack of integration matters more. For example, the threat of losing customers to competitors who can service their customers faster and cheaper because their order processing system is nicely integrated with payment and shipping system is real. To survive in the fiercely competitive market, several companies have embarked on streamlining initiatives to cut product development time and to reduce product delivery time. To achieve this, enterprise-wide integrated systems such as the following are needed (see [Kalakotta 2002a, Carter 2007] for numerous examples and case studies):

- Procurement systems that link order processing with payment, inventory management and shipping

- Manufacturing systems that link suppliers, designers, product managers, and production planners in a uniform manner.
- Customer support systems that link customer service with customer relationship management, marketing and sales.
- Health information networks that link various hospitals, doctors, pharmacies and health insurance providers
- Supply chain management systems that link several suppliers with the material requirement planning (MRP) systems of consumers

Two sidebars (“Case Study: Bharti Airtel Enterprise Architecture Framework” and “Case Study: Bombardier Aerospace Adopts Flexibility”) illustrate flexible enterprise architectures in practice.

How can an EA help in enterprise integration efforts? Enterprise integration means making independently designed enterprise systems work together. For enterprise integration, the goal is to provide standardized high-quality customer service across the entire firm’s service channels. Multi-channel integration is critical because customers expect consistent service when they interact with a company, no matter which channel they use. Multi-channel integration is also a critical issue for any business striving to maintain its competitive advantage [Kalakota 2002a]. As we will see later, most definitions of enterprise integration touch on similar if not common concepts related to *working together*, *sharing*, *interacting*, and *collaborating*. Naturally, a well documented EA with clearly specified interfaces and interactions between various business and technical components, provides the basis for well integrated systems.

Case Study: Bharti Airtel Enterprise Architecture Framework

Bharti Airtel, a large telecommunications provider based in India, thrives on its ability to form partnerships quickly. Bharti’s business strategy is to partner instead of build -- it has commercial outsourcing contracts with IBM, Wipro, Nortel and Infosys, and network technology contracts with Alcatel-Lucent, Nokia Siemens and Ericsson. Behind these key partners there are approximately 120 different technology partners including Oracle, Cisco and many others. Due to these partnerships, Bharti’s business has been growing almost exponentially – it went from almost nothing in 2003 to over 100 million users in May 2009.

Instead of assuring that the internal company operations are working more efficiently, Bharti is utilizing SOA-based architectural frameworks to form partnerships more quickly. The Bharti architecture utilizes SOA concepts to support more than 100 million subscribers. The Bharti enterprise architecture framework (EAF) consists of three independent but related architectures:

- Business architecture that concentrates on how business functions (e.g., marketing, finance, sales, billing) work with each other,
- Application architectures that identifies the role of data, applications, and integration to support the business architecture, and
- Technology architecture that shows how data technologies, applications technologies, and integration and collaboration technologies support the application architecture.

Sources: Martinez, F., and Narayanan, J., “Strategic Outsourcing at Bharti Airtel Limited”, Harvard Business Case Studies, 9-107-003 and 9-107-003, plus personal contacts with Bharti Management

Case Study: Bombardier Aerospace Adopts Flexibility

Bombardier Aerospace is a Montreal, Canada, based aviation company with 28,000 employees and locations in Canada, US, and Ireland. Due to the intense competition in the aerospace industry, the company is trying to gain competitive advantage by making their internal processes more efficient and flexible. Specifically, Bombardier needed to be able to track products, fulfill customer's orders faster and maintain better control of products in its warehouse. The company also had difficulty identifying spare parts among different manufacturing lines which resulted in duplicate orders and shipment delays (the old "left hand not knowing what the right hand is doing" syndrome). Recent mergers and acquisitions introduced multiple silos of information that introduced more complexity and duplication. Bombardier relied on agility and on-demand techniques to ensure flexibility by:

- Integrating disparate sources of information throughout the company
- Streamlining the business processes and accelerating the supply chain

For example, Bombardier can now place orders through its ERP (enterprise resource planning) system and can immediately view what has been ordered and what parts are required to fill the order. This has significantly reduced the time to order and made the company more competitive. In addition, it has reduced the cost of adding new features between 50 to 60% and the time lag by 30 days (from 40 days to 10 days).

Source: "Bombardier Aerospace: Business Flexibility Strategy Takes Flight", [Carter 2007, p: 17-18]

Enterprise integration can be at several layers (e.g., business process integration, application integration, platform integration). However, enterprise application integration (EAI) receives most of the attention due to the following main reasons:

- Lack of integration between enterprise applications is very visible to the customers and business partners. For example, if an order processing system is not integrated with a payment system, then the customer has to place an order on one system and then go back and pay by using a totally different system – possibly having to re-enter all information again.
- Many of the enterprise applications can be "legacy" applications that are old, unstructured, and monolithic. According to Webster, "legacy is something *of value* that is passed along to the next generation". Dealing with legacy applications has been a dominant concern of IT management for many years. If possible, the IT management would like to keep the legacy systems intact because they provide vital services (e.g., billing) that are very risky to disrupt. However, something must be done about these systems because these systems are inflexible and are becoming increasingly expensive to maintain especially in the modern enterprise scenarios.

Chapters 9 through 13 discuss issues in enterprise application integration in great detail.

Example: Developing Architecture of a City – Lessons for IS Architects

Development of integrated architectures for enterprise applications that span organizational units and enterprises is similar to establishing design of a city for an ever-changing and ever-evolving industrial and residential population. We have to worry more about how the individual parts of the city will be known to the city dwellers and how will they be interconnected (i.e., the infrastructure needed), instead of how the individual buildings will be designed internally. We only establish policies, rules and guidelines for the building externals and focus more attention to the bigger issues

of access and flows between the buildings (i.e., all buildings must be accessible). In a similar vein, integrated architectures of enterprise applications is like designing many mini applications that need to interact with each other for corporate business goals. The emphasis is on identifying the interfaces of the applications, and the infrastructure needed to make this application operable as an enterprise-wide as well as, if needed, inter-enterprise application.

1.3.4 Enterprise Architectures and Integration – A Closer Look

As stated previously, an enterprise architecture describes the enterprise building blocks (the business layer, the application layer, and the technology infrastructure layer), what they do and how do they interface/interact with each other. Let us use Figure 1-7 for a closer look at enterprise architectures. This figure shows a more detailed view of the enterprise building blocks (business processes needed for the business, enterprise applications that automate the business processes, computing platforms and middleware services that support the applications, and the network services that interconnect the various platforms in an enterprise). These building blocks are represented as horizontal layers – higher level layers are more business oriented and lower level layers are more technology oriented. Different types of architectures at different layers can be envisioned as shown in the vertical bar of Figure 1-7. For example, business architecture represents the architecture at business process layer, enterprise application architecture represents architecture at application layer, etc. Thus an enterprise architecture represents all the architectures at all layers of an enterprise, i.e., it is the vertical bar in Figure 1-7. Based on this, we can introduce the following definitions of enterprise architectures:

Definition 1. Enterprise Architecture = architecture of architectures.

Definition 2. Enterprise Architecture = Business Architecture + Application Architecture + Computing Platform Architecture + Network Architecture

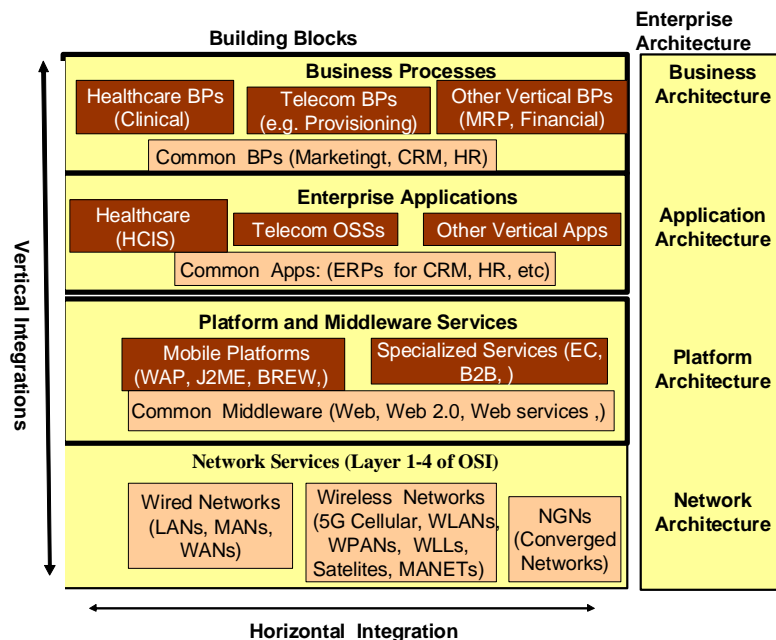


Figure 1-7: Building Blocks of Enterprise Architecture and Integration

Let us now include the integration consideration. The objective of an *integrated* enterprise architecture is to show how *well* all the business plus technical components work together to serve the enterprise needs. Development of an integrated enterprise architecture, referred to as integrated architecture in this book for simplicity, generally starts with documenting the organization's strategy and goals. The integration process concentrates on the interactions and the interfaces between the enterprise structural components, at the following layers shown in Figure 1-7:

- Business architecture that basically describes the business processes and how they interact/interface with each other.
- Application architecture that shows the various application software packages and how they interact/interface with each other through messages and data flows. This may include an information model that shows how the information flows between various software components.
- Computing platform architecture with interactions and interdependencies between different operating systems, system software packages and middleware services located on various desktops, servers, and mainframes.
- Network architecture with Intranet, Extranet, Public Internet and network devices interconnected through various connectivity devices and gateways.

An EA diagram such as Figure 1-7 serves as a very effective framework for enterprise wide integration -- facilitating vertical as well as horizontal integrations:

- **Vertical integrations** show a business architecture that is integrated with technology architecture (enterprise applications, platforms and networks) of a company or a division of a company. It combines business, applications and IT infrastructure components into a solution for a particular situation (typically known as a “silo”). An example of vertical integration is a supply chain management ERP system that automates all supply chain processes and operates on Linux platforms.
- **Horizontal integrations** show how processes and technologies at the same layer are integrated. For example, the integration of business processes in sales with business processes in supply chain represent a horizontal integration at business process level. Similarly, enterprise application integration represents how different ERPs within an organization seamlessly work each other and inter-enterprise (B2B) application integration architectures represent supply chain management application integration across multiple enterprises. As another example, smooth transition between wired and wireless networks (e.g., roaming support between a cellular phone, a Wi-Fi LAN and a wired corporate Intranet) represents a horizontal network integration.
- **Mixtures** represent an integrated architecture that is a combination of vertical architectures that interconnect different layers as well as the horizontal architectures at the same layers of an enterprise. In many practical cases, mergers and acquisitions lead to these integration scenarios because many organizations have vertically integrated systems but when two or more organizations merge, multiple vertical architectures need to be integrated horizontally – a real headache. This is known as the “information silo” problem, as mentioned in the Bombardier Aerospace case study previously.

Based on this discussion, we can introduce the following definitions of *integrated* enterprise architectures:

Definition 3. Integrated Enterprise Architecture = Horizontally Integrated Enterprise Architecture + Vertically Integrated Enterprise Architecture

Definition 4. Integrated Enterprise Architecture = Enterprise Architecture + Integration Technologies (for vertical plus horizontal integrations)

Sayings About Good Architectures

“We shape our buildings and afterwards our buildings shape us” -- *Winston Churchill*

“While any single product is apt to become quickly outdated, a well-designed and open-ended architecture can evolve along with critical technologies, providing a fixed point of stability for customers and serving as the platform for a radiating and long-lived product family” -- *C. Morris and C. Ferguson, “How Architecture Wins Technology Wars”, HBR, March-April 1993*

1.3.5 An Example – Frank’s Furniture Store (FFS)²

1.3.5.1 Example Overview

We will use Frank's Furniture Store, New York City (NYC), as an example to illustrate the key points in the balance of this chapter. FFS is a small store with big ideas. Frank started selling kitchen and bedroom furniture 5 years ago and wants to expand aggressively in the next 3 years. He currently has 80 employees in NYC and is partnering with a mover to deliver the items. His plans are:

1. Next year he wants to acquire a small manufacturing shop so that he could design, build, sell, and repair custom built furniture. He also wants to open five furniture outlets, in different parts of the country, to sell his furniture. He expects to double the size of his company next year.
2. In two years, Frank wants to diversify into a wide range of other products (e.g., living room and office furniture, paintings). He also wants to start partnering with other retail stores and manufacturers. The parts and components will be brought from suppliers located overseas to his manufacturing site.

Frank is a good businessman but is not very technical. He keeps track of all information on a MS Word file and also uses an MS Excel spreadsheet occasionally. Currently, all communications are through phone but Frank is pursuing an MBA and is really intrigued by using IT for selling, purchasing and outsourcing. He is especially interested in integrating and automating the procurement processes (e-procurement) and supply chains to provide custom-built furniture quickly.

He has no idea what he is getting into. Besides his MBA, he has been attending management seminars on use of IT in business. He does not completely understand it but he is convinced that it is something very good (they wouldn't be teaching courses in this area if it was not good!). He simply cannot wait to put everything he is learning to work. His goal is to eventually become a major digital corporation that will serve as a virtual store for multiple shops so that potential customers order a variety of products through him. He will receive the orders and try to fill them, if he can. Otherwise, he will route the order to one of his business partners. He is fascinated by the idea of exploiting IT to compete in the marketplace.

He knows about many failures (dot bombs) and wants to be aggressive but cautious. For example, he knows about the failure of Furniture.com (see the sidebar “Case Study: Furniture.com Goes Out of Business”) and wants to make sure that he does not follow the same route. Basically, his goal is to significantly grow his business by using IT in an innovative manner. He also wants to make his

² This example is based on a real life retail store.

operations more efficient and less expensive. He wants to use the Furniture.com model without the problems. He needs help in developing an EA and an overall IT plan that includes business processes, applications and the enabling IT infrastructure.

Case Study: Furniture.com Goes Out of Business

Furniture.com was reviewed by CIO Magazine in the article "Furniture.com," Jan. 15, 2000. The company was selling furniture over the Web and promised Web shoppers 24-hour browsing and six-to eight-week delivery times on everything from table lamps to 10-piece bedroom ensembles. The company reported \$22 million in net revenues for nine months ending September 2000 and attracted 1 million users a month. But the increase in usage also increased customer dissatisfaction. Customer complaints filed with the Better Business Bureau (BBB) in Worcester, Mass., jumped from one in 1999 to 149 in 2000 (most brick-and-mortar companies get three to four complaints a year). The most common complaints had to do with delivery problems, product quality and bill disputes.

The main problem was that the company management built the Furniture.com brand very well but they did not create the infrastructure needed to support it. The company under-estimated the logistics and costs involved in shipping such a bulky commodity cross-country and did not build a good way to track orders -- the company ended up tracking orders manually. Furniture.com also created a cancellation policy that was too expensive. The customers could, for example, cancel orders right until delivery day. Thus when six-week delivery turned into six-month delays, many orders were cancelled. Furniture.com closed down and filed for bankruptcy in November, 2000.

Reference; "The Changing Landscape of e-Business -- The Survivors" by Stephanie Overby, May 1, 2001 Issue of the CIO Magazine.

1.3.5.2 Sketch of an Enterprise Architecture for FFS

It is a good idea to start by developing a high level EA for FFS based on the discussion so far. This EA would comprise of a business architecture, an application architecture and an IT infrastructure architecture. The composite EA would show the business processes of FFS, the applications that automate the business processes, and a technical specification that shows what pieces of information will be stored where and in what format, how the customers can locate the furniture and order them, and how the employees can ship them and settle payments, etc. This will also include platform and network details such as Web technologies being used, how is mobile computing being used, what type of enterprise-wide network services are being provided to the customers and employees, etc.

Let us first start with business architecture and integration. Figure 1-8 shows a business process pattern (BPP) that could serve as a basis for a business architecture for FFS. Specifically, this figure shows a BPP for retail industries that captures a very high level view of enterprise business processes (e.g., procurement, sales and marketing) and the key interactions between these processes. This high level business view is a good starting point for an integrated business architecture because it shows the supplier/partner focused BPs (e.g., production, supply chain management, distribution) and their interactions/interfaces with other BPs of the enterprise. For example, this figure can be used to answer

the query: if distribution BPs are reengineered, what other BPs will be affected It can also help a business develop a BPO (Business Process Outsourcing) strategy, an enterprise application strategy (i.e., what BPs to automate), and an integration strategy. BPPs provide a powerful tool for representing a wide range of enterprises in different industry segments. Additional information, as separate documents linked from this diagram, to represent corporate goals and strategies can easily upgrade this diagram into a solid business architecture.

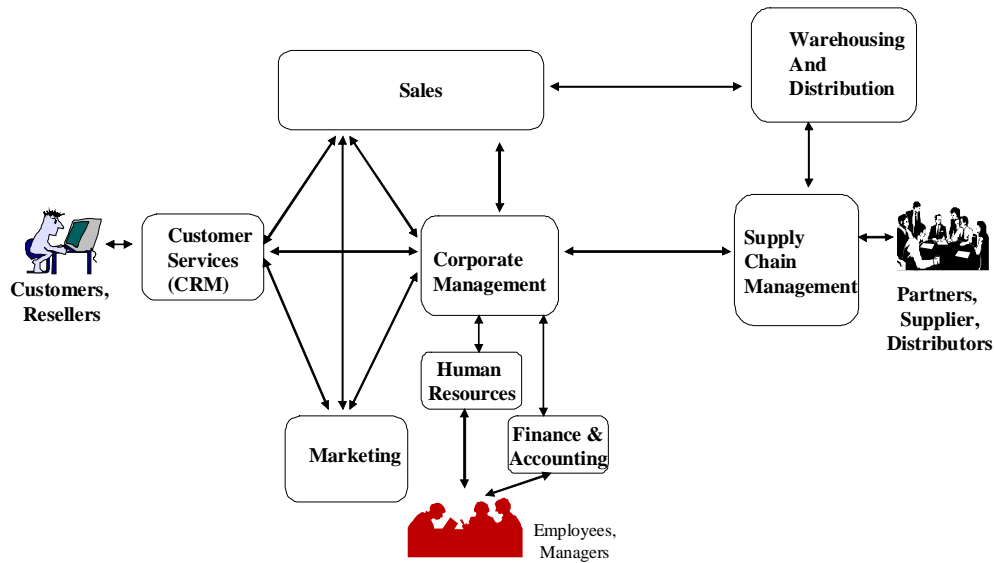
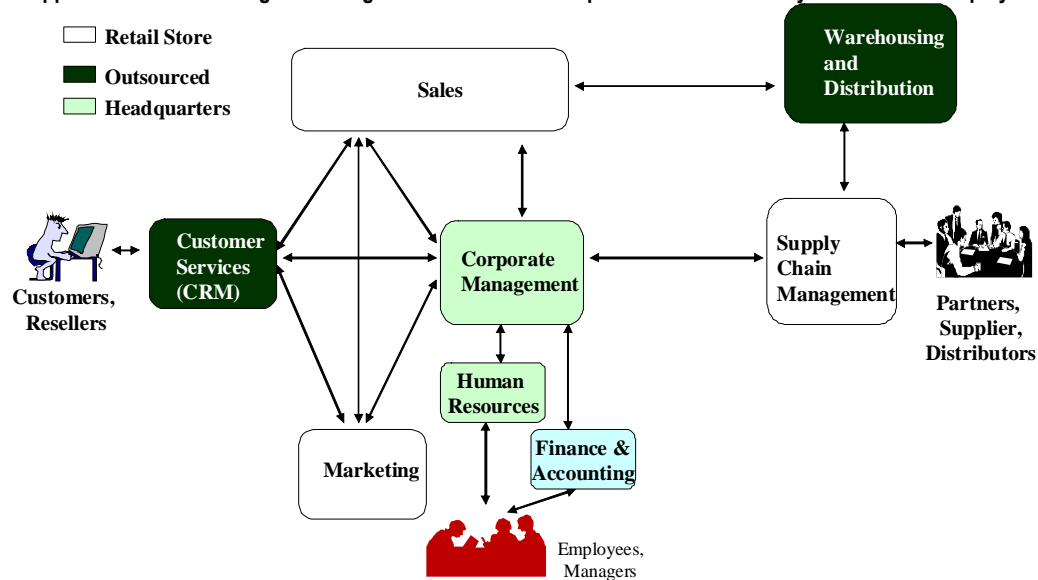


Figure 1-8: Sample Business Architecture of a Store like FFS

Application architectures show the application components, the interrelationships between these components, their allocations, and their coordination paradigms. Application architectures at enterprise level raise several portability and interoperability issues because they tie several "local" applications together to satisfy business requirements. A complete application architecture gives enough information to the implementers so that they can build and deploy a



system.

Figure 1-9 shows a possible logical application architecture of the FFS. Through color coding, it shows what applications reside where (headquarter, retail site) and which ones are outsourced. This architecture does not show any infrastructure components and thus is a Technology Independent Model (TIM) of the system.

Platform (infrastructure) architectures provide the set of technologies (middleware, networks, operating systems, hardware, etc.) that glue together the application pieces across an enterprise. For example, the enterprise applications may use a combination of middleware such as Web technologies, Web Services and database gateways that operate over the Internet across Windows, Linux, UNIX and mainframe platforms. Figure 1-10 shows a sample solution architecture that translates the given logical application architecture into a physical architecture that includes infrastructure components such as Web servers, networks, VOIP systems, etc. This is a Technology Specific Model (TSM) for FFS.

Thus the three diagrams presented in this session capture the essence of an EA for FFS, albeit at a high level. This EA can be used to develop current and future IT plans. We will go through the details of these architectural components later in this chapter.

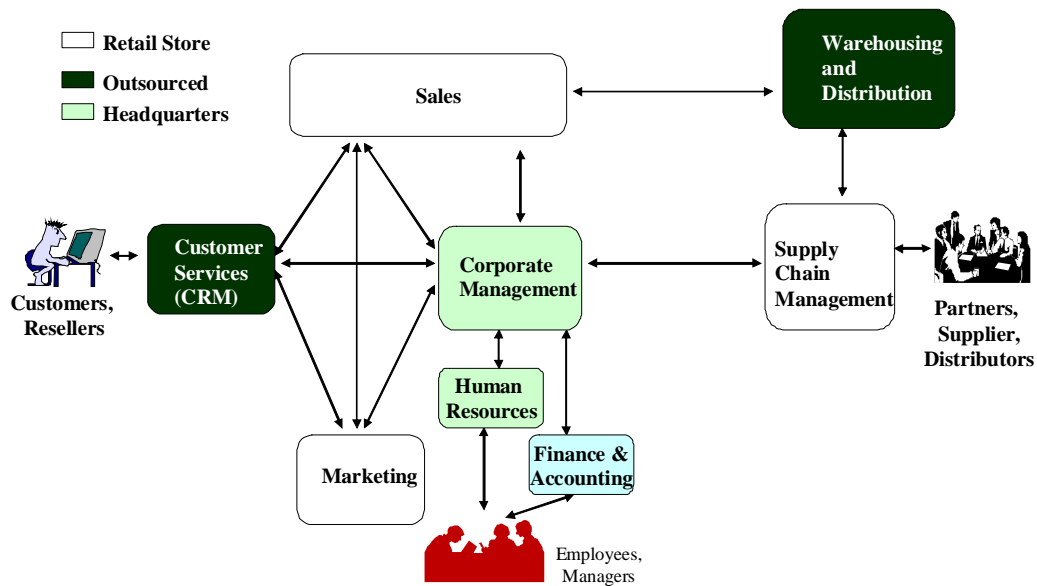


Figure 1-9: Logical Application Architecture (Technology Independent Model) of FFS

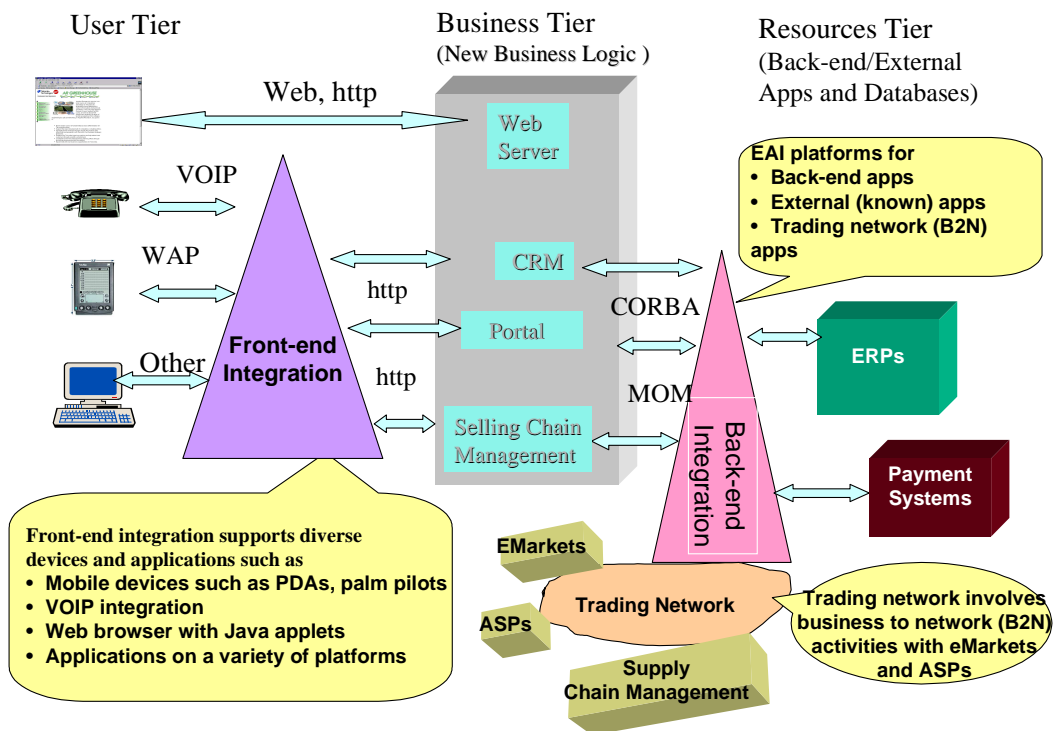


Figure 1-10: Solution Architecture - Physical Architecture with Technology Choices (Technology Specific Model)



Suggested Review Questions Before Proceeding

- What is an enterprise architecture – please define in your own words
- Create a prioritized list of the benefits of an EA
- What is the difference between EA and IEA
- How is integration of information silos related to integrated architectures
- How can a merger and acquisition cause horizontal integration of vertical architectures



Time To Take a Break

- ✓ • Enterprise Architecture & Integration
 - SOA for Integrated EA
 - A High Level Methodology
 - An Automated Toolset

1.4 Enterprise Architectures and Integration Through SOA

EA of an integrated corporation comprises of a very diverse array of processes, technologies and frameworks. In particular, different enterprise architecture frameworks have been proposed over the years. They include Zachman, Martin, Spewak, Gartner and others. See the article by [Sessions 2007] for a very good comparison and analysis of the top four EA methodologies. These frameworks represent EAs through different types of diagrams and artifacts such as UML diagrams, data flow diagrams, process diagrams and natural language descriptions. This book proposes that SOA (Service Oriented Architecture) provides an elegant framework for representing and implementing an integrated EA. As we will see, SOA provides a loosely coupled architecture which allows business services to discover and communicate with each other over a standards-based infrastructure and thus leads to enterprise-wide flexibility and adaptability,

1.4.1 A Service Oriented View of Business

All businesses provide a set of services. Some services are provided to the customers (B2C), some to other businesses (B2B) and some to the employees (B2E). For example, Figure 1-11 shows a very high level view of a retail store that provides marketing, sales, customer support, and many other services (some are customer facing, some are supplier facing, and some are employee and management facing. In the highly fluid business environment of today, some of these services are provided by other service providers (outsourcing agencies, business partners, etc). For example, in this organization, customer services, marketing, human resource (HR) management, and finance and accounting (F&A) services are provided by other service providers (SPs). The task of the enterprise management is to find the best service providers (SPs) to run the firm. In addition, a company can

change its business by adding new services from new SPs. For example, a wired telephone company can add a wireless service provider, a manufacturing company can add a retail outlet provider, etc. In addition “service bundles” can be created by different SPs to meet user needs and to compete for user business. The idea is that companies may add, delete, change and merge SPs that provide the best services to compete.

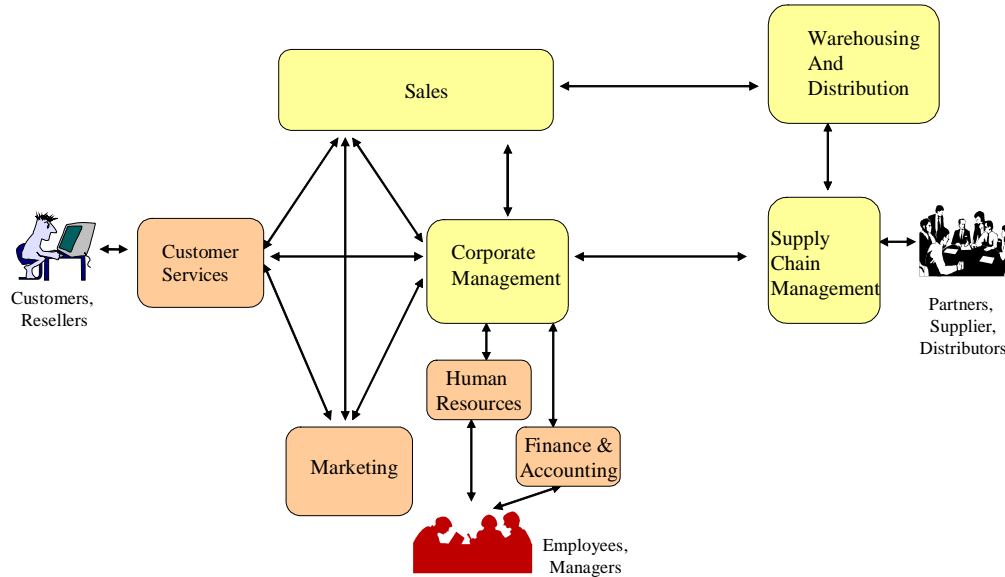


Figure 1-11: Service Oriented View of a Retail Store (Darker Blocks mean Outsourced/Rented Services)

How can enterprise software support this service-oriented business climate? The answer is that business software is developed as *business components* that can be assembled with other business components to provide business services. For example, a large grained business component (BC) -- a software package from PeopleSoft -- could provide the HR business service (BS). Similarly another BC from SAP could support the marketing BS and the like. A company could choose, assemble and run these BCs from different suppliers to support its BSs. A company could also replace a BC from PeopleSoft with a BC from SAP to provide better services, if needed. More interestingly, an order processing BC residing in Atlanta could check the inventory managed by a BC in Detroit or Singapore. This implies the following:

- There is a BC that provides a set of business services -- this is the service provider
- The services are well defined so that other BCs can understand them
- BCs have well defined interfaces so that they can work with each other
- BCs from different suppliers can be used to provide a business service
- An IT infrastructure (middleware service) exists that allows services provided by components to be advertised, discovered, selected, and invoked over the Internet

The following sections provide a few more details of the key components of SOA. Chapter 9 provides technical details of SOA and detailed discussion of how SOA can be used to architect and integrate enterprise wide systems is given in Chapters 10 through 13.

1.4.2 Service Oriented Architecture (SOA) at a Glance

Service-oriented architectures (SOAs) rely on services and the components that provide the services as the fundamental elements for developing applications. The main idea of service oriented architectures is that the applications should be thought of in terms of the services they provide and the individual components that actually deliver the services. The services can be combined into aggregate services and similar components can be combined into applications. Thus a bank, for example, provides a set of services (e.g., deposits, withdrawals, fund transfers) and these services are provided through components that can be combined into banking applications.

Definition: A service-oriented architecture is based on the following three fundamental features:

- **Reusable Components:** It is important to decompose business applications into business components (BCs) in such a fashion so that as many components as possible are general purpose (i.e., reusable) and as few as possible are special purpose. It is highly desirable to create common services and components that can be reused to serve many different requests.
- **Web-Services Enablement.** The components must have well defined service interfaces that can be stored in a directory so that service clients (SCs) can query an interface directory to discover and invoke the needed service providers (SPs). Although older technologies can be used for service definition and discovery, Web Services (WS) is the favored enabling technology at present. We will discuss WS in chapter 7. Due to the reliance of SOA on Web Services, Gartner calls it WOA (Web Oriented Architecture).
- **Enterprise Service Bus (ESB):** Instead of point to point communications between service clients and service providers, a loosely coupled common middleware infrastructure must be used for communications, brokerage, security, directory and administration services needed throughout the enterprise. This infrastructure is called Enterprise service Bus (SB). We will discuss ESBs later.

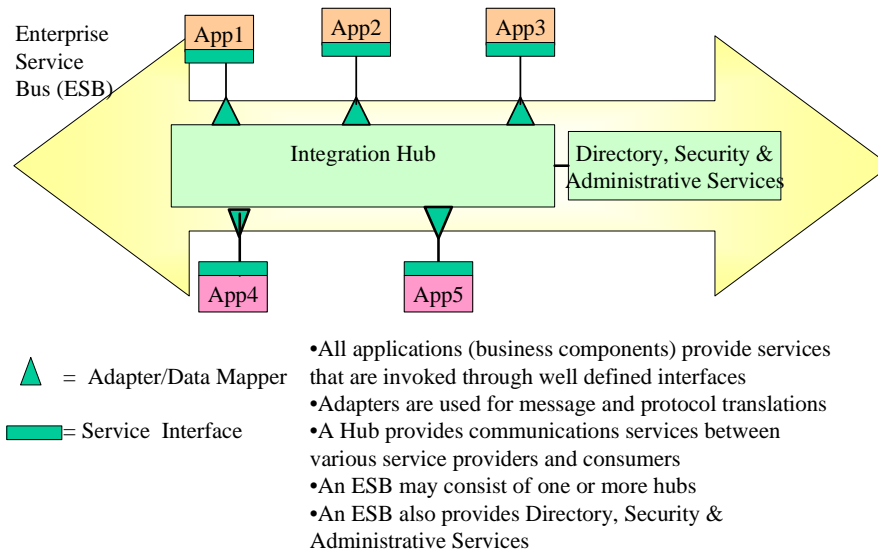


Figure 1-12: Conceptual View of SOA and an Enterprise Service Bus (ESB)

These somewhat naïve requirements lead to a very powerful architecture which can support and promote highly flexible and reusable business services for the current and future enterprises. Figure 1-12 shows a conceptual view of an SOA-based architecture supported by an ESB.

1.4.3 How SOA Can be Used in EA (Enterprise Architectures)

SOA can be used in developing and building an integrated enterprise architecture. Specifically:

- Business architecture can be represented in terms of business services (BSs). This view was represented in Figure 1-11
- Application architecture can be represented in terms of a set of business components (BCs) that automate business services (BSs)
- IT infrastructure can be represented in terms of the ESB that shows how different infrastructure services support the business services and business components.

Figure 1-13 presents an SOA oriented view of an enterprise architecture. It shows different application and an ESB as a collection of hubs that are interconnected to each other. In addition, each hub serves a subset of applications. For example, a hub is dedicated to handle the front-end of an enterprise and thus can be viewed as a 'Portal Hub'. Similarly there is a B2B Hub to handle all B2B traffic. Many other hubs can be envisioned to handle, let us say, a data warehouse, a division of a company, or even a newly acquired company. In reality, a hub could be a server that is dedicated to a specific type of application or users. A small company may start with one hub but as the organization grows, more hubs can be added to the ESB. In addition, each new acquisition can be assigned a hub. This allows a great deal of business flexibility and control. We will discuss different aspects of an ESB in chapters 9, 10 and 11.

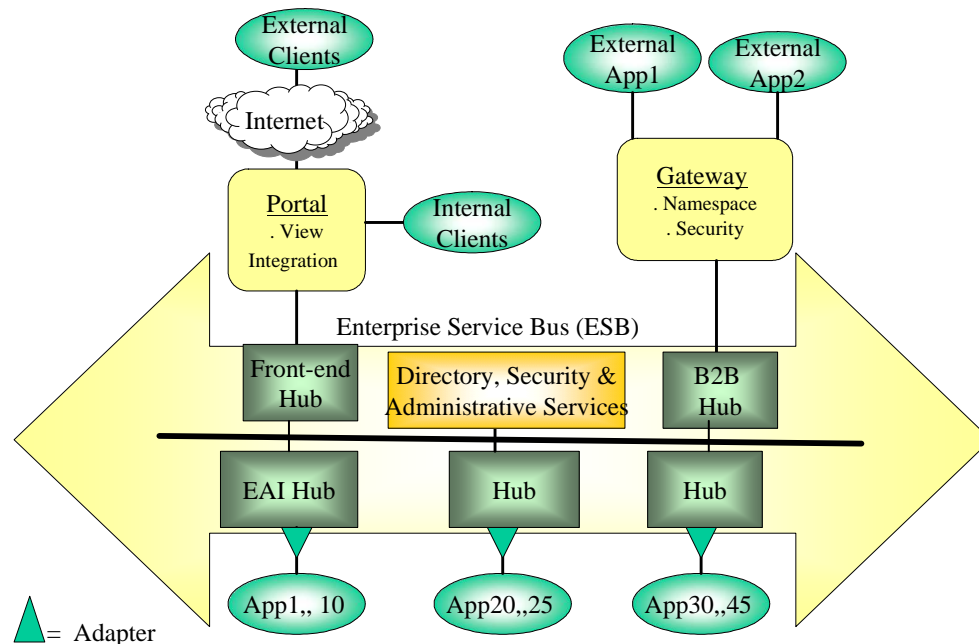


Figure 1-13: SOA Oriented View of EA

B2B trade spans a large set of activities such as supply chain management, B2B emarkets, and business networks such as hospital information networks. In addition, coalitions and the popular 'cloud computing' paradigms introduce several B2B scenarios. SOA can play a major role as the enabler of B2B trade. For example, the ESB Directories can serve as brokers for discovering and invoking new services for B2B trade. Figure 1-14 shows a possible B2B integration architecture based on SOA. The key player in this scenario is the B2B integration bus that enables communications between the organizations. The main advantage of this approach is that as new

players join the B2B trade, they are added to the B2B registry (directory of B2B partners) and are discovered by the participants when they search the registry. We will discuss B2B trade extensively in Chapter 12.

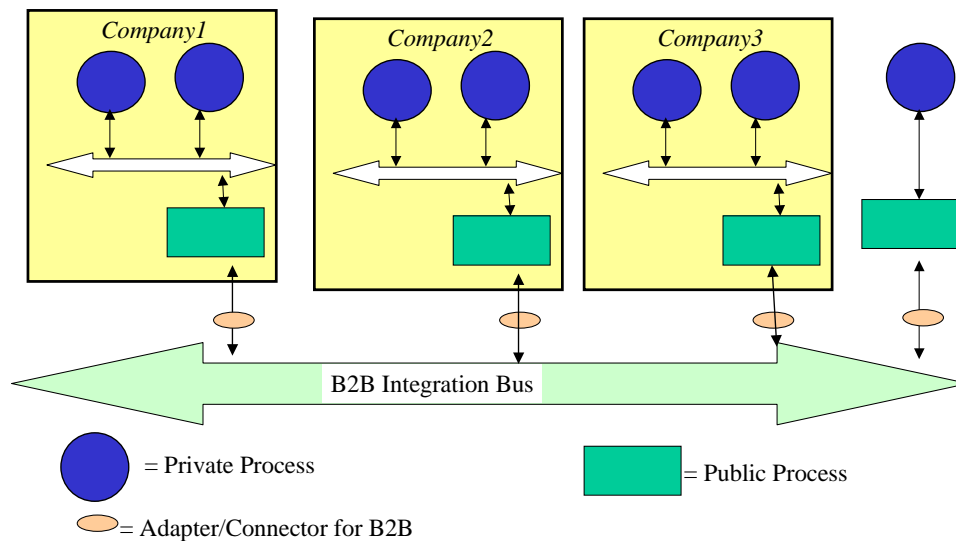


Figure 1-14: B2B Integration Architectures

While not perfect and not a panacea, SOA does provide an elegant architectural framework that can be used to describe an EA and also to integrate the various components of an enterprise, internally and externally. In fact, SOA supports the currently popular cloud computing paradigm (see the sidebar “SOA for Cloud Computing”).

SOA for Cloud Computing

Cloud computing (CC) is becoming popular at present for flexible, robust and inexpensive computing services – mostly from service providers (“cloud vendors”). Although definitions vary widely, the main idea of CC is that all IT-related capabilities are provided “as a service” (e.g., software as a service (SaaS), platform as a service (PaaS), Infrastructure as a service (IaaS), etc. Different providers, residing in the cloud (e.g., the Internet) can provide these services. This allows the users to access a very wide range of technology-enabled services from the Internet without ownership, control, knowledge, or technical expertise of the complex IT infrastructure.

SOA, in principle, promotes the cloud computing” paradigm. In particular, an ESB can be viewed as an infrastructure cloud that provides the infrastructure capabilities (integration servers, directories, routing, and security) needed to run enterprise applications.

SOA Main Sources of information

- IBM System Journal, Service-Oriented Architecture Special Issue, Volume 44, Number 4, 2005.
- IEEE Computer Society Technical Committee on Services Computing -

www.servicescomputing.org.

- Bieberstein, N., et al, "Service-Oriented Architecture (SOA) Compass: Business Value, Planning, and Enterprise Roadmap", IBM Press, Oct 2005.
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- IBM site on SOA (www.ibm.com/soa)
- Sun site on SOA (www.sun.com/soa)
- Comm. Of ACM, Special Issue on Service Oriented Computing, Oct. 2003.

1.5 High Level Methodology for Integrated Enterprise-Wide Architectures

1.5.1 Overview

The discussion so far has mentioned several decisions and choices that need to be made during an enterprise architecture and integration effort. A methodology is needed to guide the system developers through these decisions. Before proceeding with details, we should acknowledge that formal methodologies have had mixed results [Inmon 1993, Mowbray 1995]. The appeal of a methodology is that it directs the developers down a reasonable path with pointers for what to do, in what order to do it, what to produce, and what to expect as inputs. However, many methodologies fail because of their linear flow of activities, rigidity in prescribed set of activities, and emphasis on diagramming tools.

Figure 1-15 shows a high level methodology that displays how individual plans can be developed and then integrated together into an enterprise wide integrated architecture. This methodology consists of several stages that address several areas of focus (e.g., enterprise focus, IT infrastructure focus, integration focus and management focus). Different areas of focus are needed for different types of business scenarios. Table 1-1 shows four broad scenario types in terms of new or existing business services which need to be introduced for existing or new sites/organizational units. This table also indicates the primary areas of focus for each scenario type. As implied in the title of this book, we will focus on enterprise and integration areas in this book. We will work through this methodology briefly here by using Frank's Furniture Store (FFS) to illustrate the key points. The discussion is intentionally at a high level to highlight the main features of the overall methodology. Details will be covered in the rest of the book (after all, this is only the first chapter!)

This methodology has several important features. First, it includes all stages needed to build a comprehensive EA -- it covers all building blocks of the EA framework shown in Figure 1-7 and also adds management and security considerations). Second, the methodology is asynchronous -- the stages can be invoked whenever enough input is available, thus more than one stage can be executed in parallel. Third, this methodology is intelligent because many inferences are used between the stages and utilizes a knowledgebase that provides patterns and COTS (commercial off-the-shelf)

information. Finally, the needed plans are developed gradually in different stages and captured in the knowledgebase (KB), thus later stages can learn from previous decisions.

Although this methodology can be, and has been, used manually, its features allowed us to build an automated toolset (described in the next section) that “gets smarter” as the user proceeds through the various stages. For example, in a manual methodology, the KB is just a collection of documents that the user can refer to. However, in an automated system, the KB is a database that contains an extensive repository of patterns, COTS information and previously generated plans. This KB can be queried, updated, and utilized by a family of “automated consultants” to infer and suggest solutions quickly etc (see the discussion of PISA later).

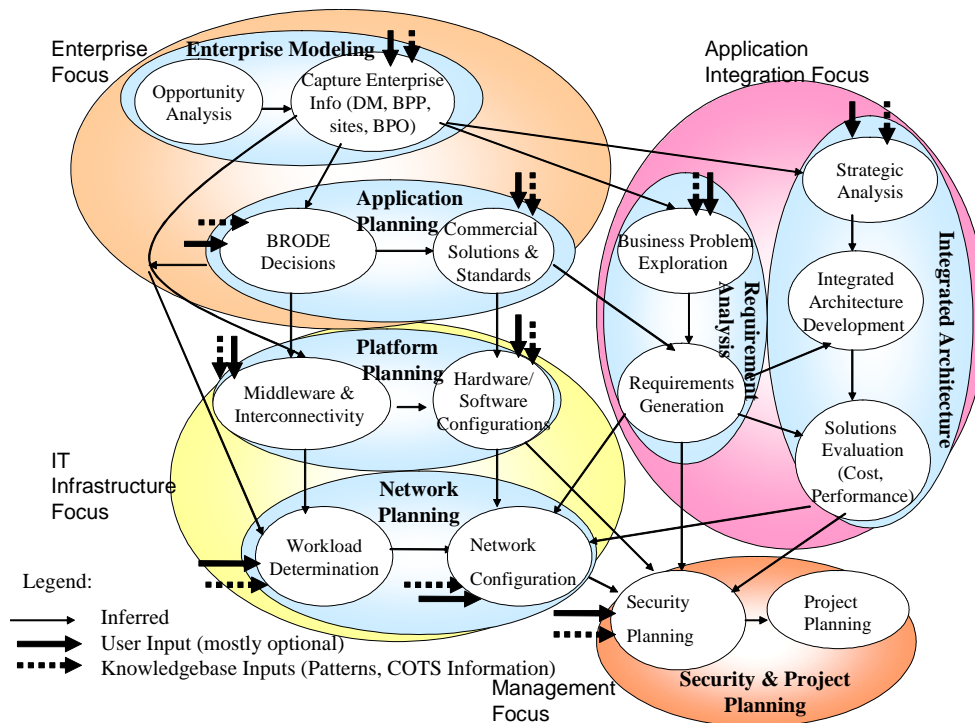


Figure 1-15: Conceptual View of Enterprise Architecture Methodology

BRODE = Buy-Rent-Outsource-Develop-Extend

EBP = Enterprise Business Pattern

WBS = Work Breakdown Structure

Table 1-1: Sample Architecture and Integration Scenarios

	New Site or Organizational Unit	Existing Site or Organizational Unit
New Business Services	<p>S1: New services(s) for a new site</p> <p>Example: New division in Chicago focusing on a new set of business services (e.g., healthcare service)</p> <p>Primary Focus: Enterprise systems plus IT infrastructure needed at the new site.</p>	<p>S2: New services(s) for an existing site</p> <p>Example: New business services (e.g., equipment repairs) for an existing manufacturing company</p> <p>Primary Focus: Enterprise systems. It may be assumed that the needed IT infrastructure already exists.</p>

Existing Business Services (Expanded/Modified)	S3: Existing business services(s) for a new site Example: Existing services (e.g., customer support) to be offered through an offshore site. Primary Focus: IT infrastructure. Needed enterprise systems may already exist.	S4: Existing business services(s) for an existing site Example: Existing business services (e.g., purchasing) of an existing company to be re-engineered for flexibility. Primary Focus: Enterprise systems plus integrated architecture focusing around purchasing.
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1.5.2 Enterprise Focus Stages

The enterprise focus is on two stages: *enterprise modeling* stage starts with a quick business opportunity analysis and captures the needed enterprise information, and *application planning* develops a strategy to automate the business processes. This area of focus is discussed in detail in the Enterprise Module of this book (chapter 1 through 4), a quick overview is provided here.

1.5.2.1 Enterprise Modeling

The objective is to create a model of the company to capture essential information such as company type, company size, workgroups (WGs) such as departments, company sites, and allocation of WGs to sites. The most important part of the enterprise model is to capture the key business services (BSs) and business processes (BPs). Some services are provided to the customers (B2C), some to other businesses (B2B) and some to the employees (B2E). For example, Figure 1-16 shows a very high level view of a retail store like FFS that provides marketing, sales, customer support, and many other services (some are customer facing, some are supplier facing, and some are employee and management facing).

In the highly fluid business environment of today, some of these services are provided by other service providers (outsourcing agencies, business partners, etc). For example, in this organization, customer services, marketing, human resource (HR) management, and finance and accounting (F&A) services are provided by other service providers (SPs). The task of the enterprise management is to find the best service providers (SPs) to run the firm. In addition, a company can expand and transform its business by adding new services from new SPs. For example, a wired telephone company can add a wireless service provider, a manufacturing company can add a retail outlet provider, etc. In addition “service bundles” can be created by different SPs to meet user needs and to compete for user business. The idea is that companies may add, delete, change and merge SPs that provide the best services to compete. We will see more detailed views of Figure 1-16 in chapters 2 and 3.

After identifying the needed business services, the management needs to make the following decisions:

- Decide which business services/processes take place at each location.
- Include business outsourcing, i.e., determine which BSs/BPs take place at the outsourced sites.
- Assign employees to sites. The number of employees at each site helps determine the type and “intensity” of work performed at each site.

Figure 1-17 shows a sample enterprise model that is developed after these decisions for FFS. In addition to the three company sites, it also shows an outsourced site because the company wants to outsource some services. The model shows what services are performed at what sites (e.g., marketing in New York, human resource management at an outsourced site, and manufacturing in Chicago).

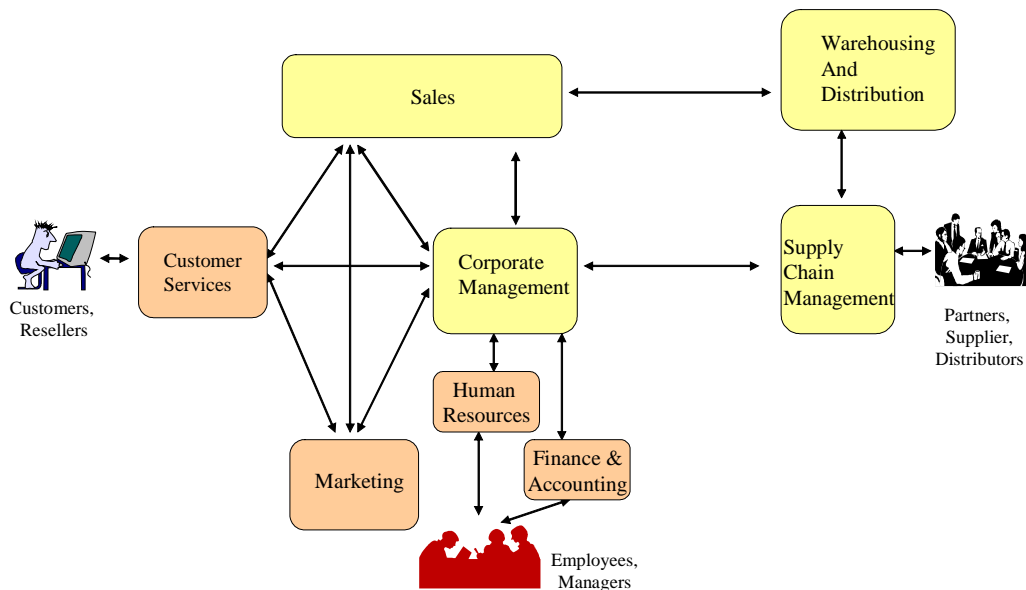


Figure 1-16: View of a Retail Store (Darker Blocks mean Outsourced/Rented Services)

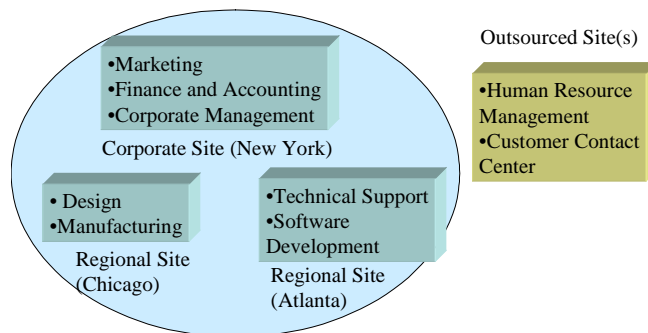


Figure 1-17: A Sample Enterprise Model

1.5.2.2 Application Planning

The objective of this stage is to identify the applications A1, A2... An that are needed to automate the business processes BP1... BPn identified in enterprise modeling. To identify the complete set of business processes (BPs), the following approach may be used:

- List all BPs that support the B2C, B2B, B2E, and other business interactions
- Keep the focus at enterprise level activities that are vital to the business. Consulting firms use “Heat Maps” to identify vital services. Heat maps are based on the Critical Success Factors [Rockart 1982] methodology. CSF instructs the managers to focus on those processes that are *critical to the success of the business*.
- Reduce duplication by clustering similar BPs into one. For example, if the same BP is used for customers as well as business partners, then it is better to cluster the two BPs into one.

- It is highly desirable to question, eliminate, and restructure business processes/services to improve organizational efficiency. This is the main idea of business process re-engineering (see chapter 2).

In reality, one or many applications may be needed to support a given business process. and a given business process may need multiple applications. For example, a customer information system may support many business processes such as purchasing, marketing, and payment. Similarly, purchasing business process needs support of many applications such as order processing, inventory management, shipping/receiving, and payment packages. The result of this step is a table that may resemble Table 1-2. Tables of this nature can be extremely revealing and are used in some IS planning methodologies such as IBM's Business System Planning [IBM 1978]. For example, the following table indicates the following:

- Application 2 does not support any business processes. This may mean that an application was developed without any business reason or it supports an outdated business processes
- Business process 2 is not supported by any application. This may indicate that this business process can be directly supported by the IT infrastructure or that this BP is being ignored.
- Application 5 supports 3 BPs. Thus replacement/enhancement of this application should be done very carefully.

Table 1-2: Applications to Support Business Processes

	Business Process1	Business Process2	Business Process3	Business Process4
Application 1	X			
Application 2				
Application 3			X	
Application 4			X	X
Application 5		X	X	X

Once the key applications have been identified, the next main activity is to develop an automation strategy with different options of buy, rent, outsource develop in-house, or extend-re-use (BRODE). It is also desirable to determine how the BRODE strategies could be implemented. For example, it is important to select the COTS (commercial-off-the-shelf) application packages that can be bought and identify application service providers (e.g., Corio and SAP) for rental and outsourcing. Finally, it is highly desirable to sketch an SOA-based architecture. These decisions can be made by using the following steps (see chapters 2, 3 and 4 for details):

1. For each BP, identify which ones will be done manually and which ones will be automated. In addition, for the automated BPs, determine an automation strategy (buy, outsource development, in-house development, or reuse). For example, if inventory management is to be automated then you can either buy an inventory management application package, or rent an inventory management service from an application service provider (ASP), etc.
2. For each option, explore the commercially available solutions (e.g. for buying, investigate and select the inventory management application packages available in the marketplace).
3. Develop sketch of an SOA-based application architecture.

Figure 1-18 shows a sample result of this stage for FFS. This example shows that FFS will buy CRM (Customer Relationship Management) and MRP (Materials Requirement Planning) software packages, rent a finance and accounting system, develop its own wireless messaging system for furniture tracking through a software development house. The application plan is based on SOA principles, i.e., all applications are treated as business components that communicate with each other

through an Enterprise Service Bus (ESB). This implies that purchased, rented and developed applications have to be “SOA compliant”. Please note that no details about the connectivity platform are provided in this stage – that will happen in a later stage. As mentioned previously, the ESB at this point is an “infrastructure cloud” that supports the applications.

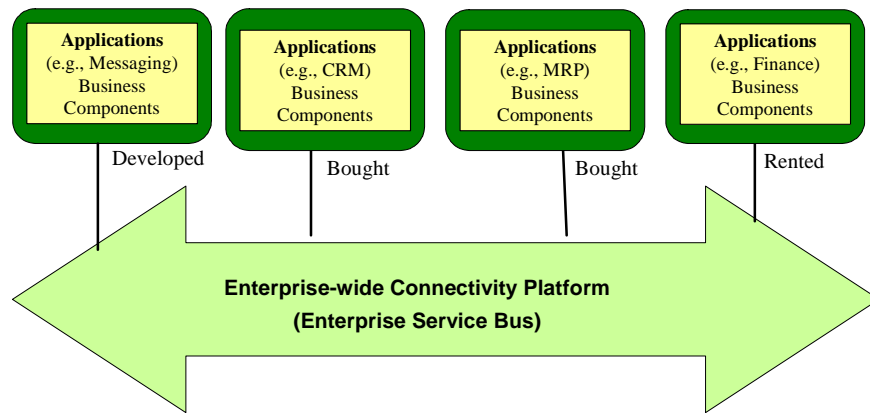


Figure 1-18: Sample Enterprise Application Plan

1.5.3 IT Infrastructure Focus Stages

IT infrastructure (platform) planning is concerned with determining the most appropriate technologies needed to *enable* the enterprise applications needed by the company. Examples of such enabling technologies are the Web technologies (including Web 2.0 and Web Services) used in corporate intranets, computing platforms on which the applications will reside, wireless and wired networks which connect all the computing platforms in an Intranet, and “Extranets” which connect many businesses for B2B trade. Details about the enabling IT infrastructure, especially Web technologies, can be found in the IT Infrastructure Module (chapters 5 through 8) of this book, a snapshot is presented here.

IT infrastructure planning can be subdivided into two broad stages; *computing platform planning* that supports the applications and *network planning* that interconnects these platforms with each other and the end-users. Computing platform planning consists of the following steps:

- Determine the middleware and Web services needed to interconnect the widely dispersed applications, users and databases,
- Identify the computer platforms, including servers, that will support the automation strategy and the application plan determined in the application planning stage.
- Decide which applications and databases will reside at which computing platforms (e.g., servers) at each site.
- Handle the software/hardware interdependencies (e.g., can a Windows application run on Linux platform, can an IIS server be installed on an XP machine, etc.)

Figure 1-19 shows a sample computing platform for FFS. The applications have been allocated to four different computing platforms -- each computing platform consists of computer hardware (e.g., Pentium processor), an operating system (e.g., Linux), some system software (e.g., MS Access), and middleware (e.g., Internet Explorer or Microsoft .NET Framework). These computing platforms are interconnected through a network that is defined later.

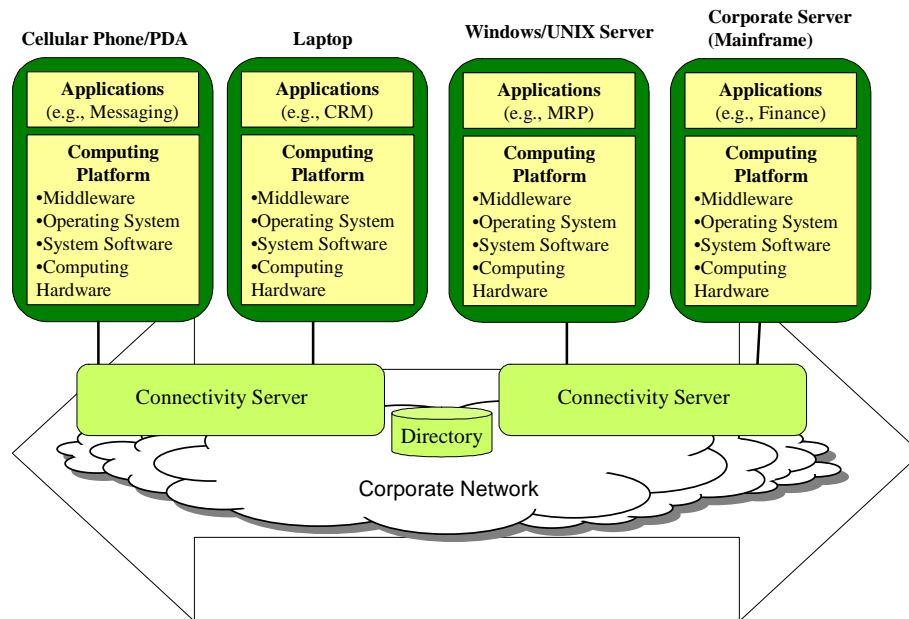


Figure 1-19: A Sample Computing Platform

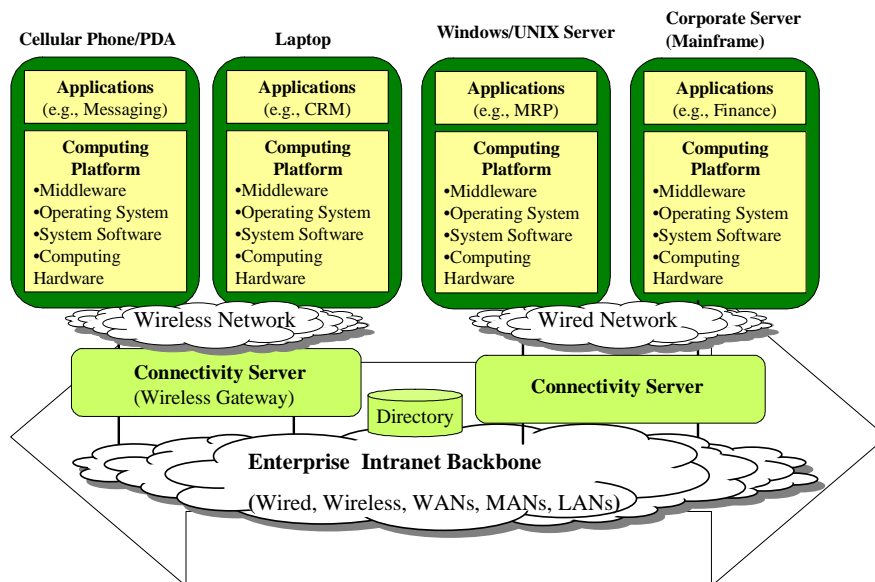


Figure 1-20: Sample Network Configuration

Network planning develops a network configuration that interconnects the computing platforms by using wireless as well as wired network elements. Figure 1-20 shows a sample network plan for FFS. Network planning involves three major tasks. First, determine the workload at each site based on the work activities at each site. Second, develop a network configuration and estimate the bandwidth needed by using queuing network models. This involves, for example, network capacity planning for the internal plus external networks depending on the type of connection (wired/wireless) and the

network traffic patterns. Finally, the type of connections and the commercially available network solutions need to be developed. Detailed network planning is beyond the scope of this book.

1.5.4 Integrated Architecture Focus Stages

The main objective of integrated architecture planning is to assure that all pieces fit together to form a working solution within the performance, security, and cost constraints. To illustrate the main issues addressed, let us consider the following situation for Frank's Furniture Store. (FFS). To improve sales, the company needs a very flexible online purchasing (OP) application that is based on SOA. The company needs help in addressing the following issues: what other applications interface with OP, how will they be impacted if OP is transitioned to SOA, what happens if OP is outsourced and hosted elsewhere in the cloud, how will OP be accessed from a wide range of user devices, what will be the most appropriate integration strategy (access in-place, data warehousing, or migration) to mesh OP with other FFS applications, what type of integration technologies will be most suitable, and what will be the cost of transitioning OP to SOA?. Additional issues include: are there commercial-off-the-shelf products that can be used for OP, what type of middleware technologies are needed to support different architectures, which ESB (enterprise service bus) platform should be used, what are the performance and security tradeoffs when different components of this application participate in B2B trade, and what type of cost/benefit analysis need to be considered while evaluating these alternatives. These are non-trivial questions that require a great deal of time and effort to answer. The following discussion presents the main ideas. Details can be found in the Integration Module (Chapters 9 through 13).

1.5.4.1 Exploring the Integrated Architecture Problem to Develop Requirements

The main focus is on developing a sketch of an integrated architecture to understand how the different applications and systems will interact and interface with each other at an enterprise level. The emphasis is on capturing the interfaces of the applications, and the infrastructure needed to make selected applications operable at enterprise as well as at inter-enterprise levels. Enterprise application architectures typically have to satisfy the requirements of the Internet age because these applications operate in an environment where thousands of Internet users can possibly access the needed resources. Specific requirements may include:

- Internet Scale: Tens of thousands of users instead of hundreds, 24x7 not 9-to-5
- Internet connectivity: Unpredictable open Internet replaces the safety of the LAN
- Multiple customers: Security and load balancing between multiple customers
- Multiple configurations: Managing diverse user profiles and configurations
- High-volume infrastructure: Providing scalable services to diverse populations

The pattern shown in Figure 1-21 provides a good starting point. This pattern assumes that the application consists of N large grained components that are arranged in several tiers: front-end integration, business logic, backend integration, back-end apps, and external (B2B) apps. This architecture pattern also includes the following integration components:

- BCs (Business Components) are the software modules that imbed the business logic of the application and provide business services.
- FICs (Front-end Integration Components) are the adapters that allow different types of user devices (e.g., mobile, handheld) to invoke the BCs.
- BICs (Back-end Integration Components) are the adapters that BCs use to interact with different back-end and external applications.

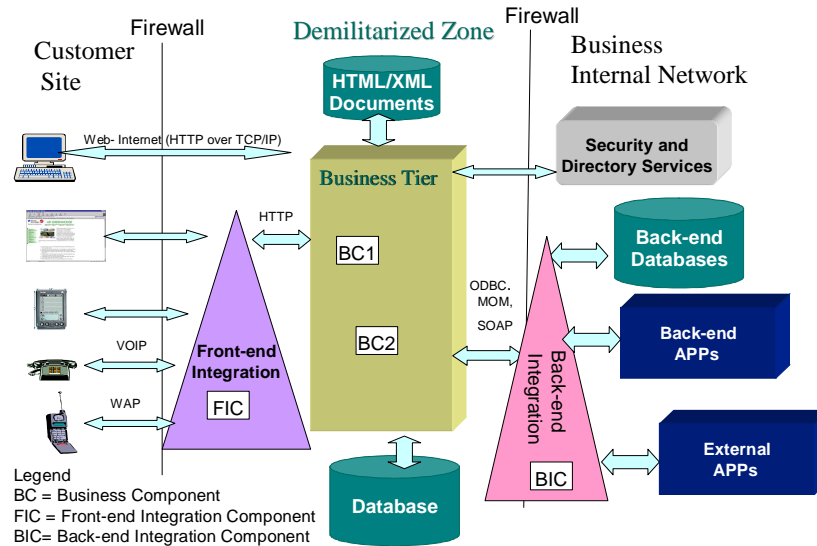


Figure 1-21: SOA-based Architecture Pattern

Determination of these integration components depends on several other factors such as hosting options and integration strategies used for internal and external (B2B) applications. To illustrate these options and their impact on integration, let us go back to the online purchasing (OP) application of FFS. If FFS decides to rent an online purchasing system from a cloud provider (e.g., use Amazon.com's purchasing system), then the back-end integration is the responsibility of the provider. However, if the order processing app is rented from an ASP but inventory and shipping reside at FFS site, then remote integration between ASP and FFS needs to be considered.

1.5.4.2 Integration Strategy and Architecture Development

The objective of this step is to develop an integrated architecture configuration that is detailed enough to reveal the complexity of the proposed architecture. This complexity, as we will see later, can be translated into cost, performance and security estimates for evaluating the proposed configuration. The complexity depends largely on the type of architectural strategies and the number and type of integration components (front-end, back-end) needed for each architectural configuration. The main consideration in developing a configuration is to choose between the following strategies for the *target applications* (applications of concern within an integration project, e.g., OP for FFS):

- **Outsourcing (remote hosting):** decide where the target applications will reside: customer site, service provider site, or a mixture.
- **Access in Place:** integrate without modifying any applications. Just access them by using adapters/mediators.
- **Data Warehouse:** build a "shadow" system to house the frequently accessed data. This is especially useful for BI (Business Intelligence) applications.
- **Migration:** re-architect and transition the target applications gradually or replace it suddenly.

Discussion of these strategies and the evaluating factors can be found in Chapter 10. The next main consideration is to translate the architecture *A* into plausible solutions (*SI, S2,,Sn*) with appropriate commercial-off-the-shelf (COTS) packages. For COTS selection, the architect has to search the COTS products available in the marketplace and select the most appropriate solution based on cost constraints, the services needed and the technical interdependencies (for example, a .NET application does not work well in a Linux environment). For SOA, the architect has to evaluate the commercially available ESB platforms from vendors such as IBM, Microsoft, BEA systems, Iona Corp and others.

Figure 1-22 shows result of this analysis for FFS. In the case of FFS, the company has decided to use the Access-in-Place strategy. In addition, it has been decided that the overall SOA-based integrated architecture consists of an ESB that is populated with an IBM Websphere ESB server for corporate services and two Microsoft Biztalk 2006 servers for departments. The individual ESB servers are logically interconnected through a directory server that routes the traffic between the servers. See chapter 10 and 11 for more details on the ESB functionalities.

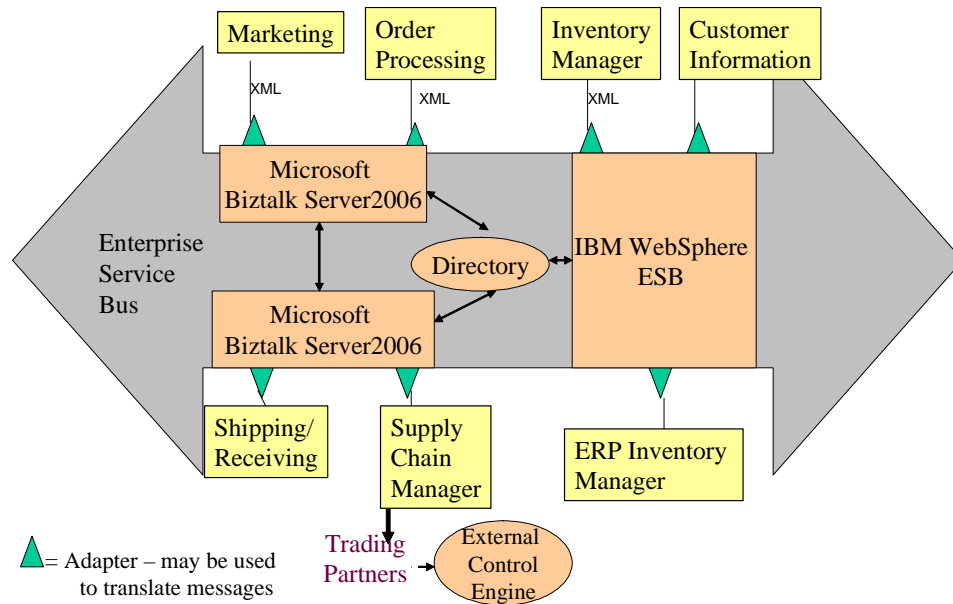


Figure 1-22: SOA Architecture for FFS (Frank's Furniture Store)

1.5.4.3 Integrated Solution Evaluation

In this stage, the solution S_i , as a result of COTS selection, is evaluated for cost, performance and security issues. For cost estimation, the effort needed to integrate systems depends on the cost of the ESB servers plus the number and nature of integration components (FICs, BICs) identified in the previous stage. From this, rough estimates of effort and cost can be obtained by using techniques similar to function point analysis [Garmus 2000]. A performance analysis of the proposed architecture can be conducted through analytical queuing models [Kleinrock 1976]. For security analysis of the architecture, risk analysis through security patterns [Kienzle 2001] can be used. A very detailed discussion of cost, performance and security analysis can be found in chapter 12 and also in [Umar & Zordan 2008].

The main results of these analysis can be captured in a table that shows the estimated cost, security, and performance for different potential solutions S_1, S_2, \dots, S_n . This table is used to evaluate and choose the most suitable solution. Table 1-3 shows such a table for FFS. The analyst can look at Table 4 and go back and generate other solutions if the results so far are not acceptable. If a suitable solution is found, then the analyst can select the choice.

Table 1-3: Sample Analysis of Candidate Solutions for FFS

Choices	Estimated Costs (\$)	Performance	Security Issues	Comments
Access-in-Place	\$120K (it is relatively cheaper to install an ESB and adapters)	2 seconds. (adapters introduce delays)	ESB & adapters may be targets for attacks & need to be secured	May need to migrate in future
Migrate and replace with an ERP	\$500K million (it is expensive to completely replace a system with an ERP system)	1 second (no adapters are needed, hopefully, for an integrated ERP system)	Security can be designed for the new system from scratch	Migrations are typically expensive and require staff training
Data Warehouse	\$200K (it is expensive to convert data and construct a data warehouse)	0.7 seconds (data level access is usually faster due to no overhead)	ETL needs to be protected, data level access needs protection	Data warehouses create duplicate data that needs to be synchronized



Suggested Review Questions Before Proceeding

- What is a methodology and why is it needed? Why the existing methodologies have had mixed results?
- What are the main characteristics of the methodology presented in this section? What appear to be the strengths and weaknesses of this methodology?
- List some examples of methodologies that you are familiar with that could be used instead of or to strengthen this methodology



Time To Take a Break

- ✓ • Enterprise Architecture & Integration
- ✓ • SOA for Integrated EA
- ✓ • A High Level Methodology
- An Automated Toolset

1.6 PISA-AIM – A Computer Aided Toolset for Enterprise Architecture and Integration

1.6.1 Overview of PISA (Planning, Integration, Security & Administration) Environment

Modern enterprises need to plan and integrate their IT services quickly and correctly to compete and survive. The methodology described in the previous section can be used to systematically guide the key players through the maze of intricate choices discussed so far. However, this methodology has several limitations:

- If used manually, it is simply too slow and error prone to meet the demands of modern enterprises.
- It is difficult to explain the intricacies and the asynchronous processes in a paper and pencil approach. For example, it is not easy to show how different scenarios can lead to different sequence of activities
- Although the methodology is based on patterns and inferences, it is virtually impossible to fully exploit these capabilities in a manual methodology. For example, users cannot flip through hundreds of patterns and rules to locate and use the most appropriate ones.

In fact, variants of this methodology have been used in an active consulting practice and the results have highlighted the need for comprehensive automated support. A survey of available tools indicated that most tools are either drawing tools (e.g., Visio) or are too vendor specific (e.g., Cisco network designer). In addition, too much attention is paid to one aspect (e.g., network planning or business process modeling) instead of how *all* the pieces of an EA (enterprise architecture) fit together. A research project, in collaboration with a startup, was initiated with the following objectives:

- Provide automated support at EA level for all stages of the methodology discussed previously instead of one narrow area. (e.g., business process modeling or security planning).
- Simulate a consulting environment where several experts collaborate with each other to solve complex problems and provide different types of support (expert advice, help in making decisions, documentation).
- Concentrate on supporting *management decisions* instead of software development activities for programmers.
- Extensively use patterns [Alexander 1977] to capture best practices in pertinent areas of work. In particular, use business patterns [Adams 2001], architecture patterns [Buschmann 2002], requirements patterns [Ferdinandi 2002], design patterns [Gamma 2006], integration patterns [Hohpe 2003] and security patterns [Kienzle 2001] to capture the available knowledge.
- Take advantage of the latest thinking in design science [Hevner 2004], knowledge services [Mentza 2001], service innovation [Chesbrough 2006], and behavioral research in accuracy versus effort of information systems [Burton 1993, Todd 1992] to instantiate the system.
- Educate the users in addition to helping them make the decisions so that they can learn the basic concepts to make better decisions on their own.

This research has produced a computer aided consulting environment that consists of a family of intelligent consultants (*advisors*), integrated around an extensive knowledgebase (see Figure 1-23). These advisors support EA activities by helping enterprises plan the new or improved services, integrate them with the existing services by using SOA, and secure and administer the resulting systems. This practice-based tool, called PISA (Planning, Integration, Security and Administration) environment, has shown very promising results and fully supports the methodology shown in Figure

1-15. At the heart of PISA, as shown in Figure 1-23, is the knowledgebase (KB) that consists of an extensive patterns repository, a commercial-off-the-shelf (COTS) database and planning models that are created during user interviews. The KB supports the PISA advisors that are segmented into three modules:

- **PlanIT** (Planner for IT) concentrates on IT planning projects and develops a plan at the enterprise level. PlanIT provides support for the enterprise and IT infrastructure activities.
- **AIM** (Architecture and Integration Module) deals with the more detailed issues of how specific components of the plan can be architected and integrated to form a functioning system based on the SOA principles.
- **SAM** (Security and Administration Module) provides security and administrative services to the entire PISA system

Each PISA advisor, as shown in the outer circle of Figure 1-23, supports a specific stage and collaborates with other advisors to produce plans. For example, the Network Advisor supports network planning stage and collaborates with the Security Advisor to develop a security plan that includes a secure network. The PISA advisors build different parts of the architecture and then allow the company to compose a comprehensive IEA.

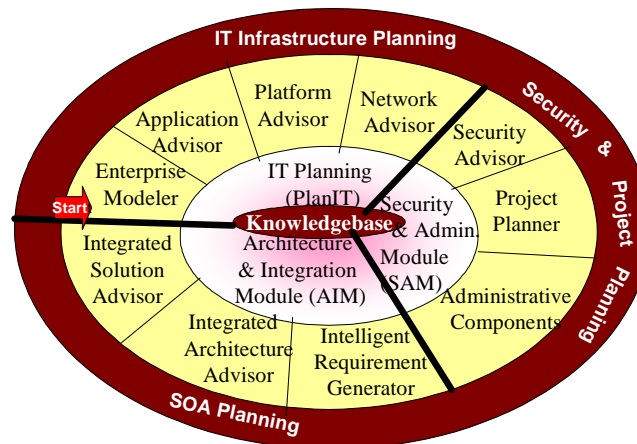


Figure 1-23: Conceptual View of PISA Environment

To understand the sequence in which these advisors are invoked, start from the Enterprise Modeler ("Start" arrow in Figure 1-23) and follow the circle clockwise. Specifically, the PlanIT advisors do the following: the Enterprise Modeler develops a model of an enterprise, the Application Advisor develops an Application plan, the Platform Advisor develops a computing platform plan, and the Network Advisor builds a network plan. The SAM advisors develop a security plan, a project plan, and provide other administrative services. The AIM advisors develop an integrated architecture plan based on SOA. The advisors are not strictly sequential – different advisors can be invoked in different sequences based on the type of business scenario. However, some things have to be done in sequence. For example, you cannot secure a network before developing a network plan (naturally!). The PISA Control Panel, discussed later, guides the user through what can be invoked when.

At the time of this writing, PISA is being used in industrial and academic assignments. In particular, the AIM module has been used on a regular basis to teach graduate level and corporate training courses on enterprise architectures and integration using SOA. Many concepts explained in this text become clearer after using PISA-AIM and many exercises can be completed through PISA.

Additional Information About PISA

For an up-to-date view of PISA, please visit the PISA website (www.ngepisa.com).

- For extensive documentation on PISA, please click on 'Learn More' button and visit the 'PISA Documents' Section of the Website
- To better understand how PISA can be used in a classroom, please click on 'Learn More' button and then visit the 'PISA in Classroom' Section of the Website.
- For sample PISA sessions, please click on 'PISA videos' on the PISA home page. .

1.6.2 Quick Tour of PISA Environment – An Example

Let us once again use the Frank's Furniture Store (FFS) example to illustrate how PISA advisors work together to develop solutions for a real life problem.

The user session, after signing in, is guided through a control panel shown in Figure 1-24. The system automatically determines which advisor can be invoked when -- this is indicated by a red arrow. In a normal session, advisors are automatically invoked in the pre-defined sequence suggested by Figure 1-23 (i.e., Enterprise Modeler -> Application Advisor -> Platform Advisor, etc.). However, a user may invoke other advisors as they become available (indicated by a yellow arrow). Each advisor, when invoked, produces a model and then returns control to the control panel. As shown in Figure 1-24, the links to the results produced by advisors used previously ("generated models"), if any, are also shown. The top toolbar provides buttons for help and the bottom toolbar provides access to a glossary, online guides and tutorials, PISA documentation, business scenario templates,

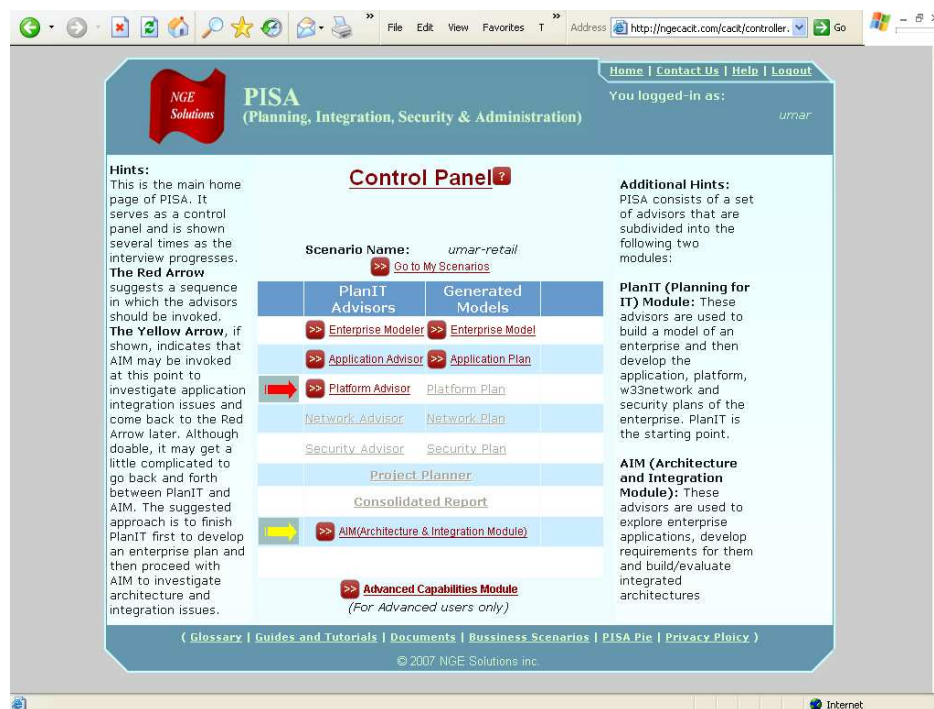


Figure 1-24: PISA Control Panel Snapshot

1.6.2.1 PlanIT Module To Develop a Plan for IT Infrastructure

The PlanIT module of PISA helps with IT planning decision through the following advisors:

- Enterprise Modeler (EM) builds an enterprise model to show what business processes (BPs) are needed by the company and where they are conducted. The user simply defines the company type, size and the four dimensions (reliance on Web, mobility, dispersion and agility) of the enterprise model shown previously in Figure 1-1. The EM fetches the appropriate business pattern from the KB and customizes it based on these inputs. EM fetches, for FFS, a business pattern that includes retail, manufacturing and design processes in addition to the sales, marketing, and internal business processes such as human resources.
- Application Advisor helps determine an automation strategy (what BPs need to be automated and how) and then suggests appropriate ERP solutions. Some business applications that automate the business processes can be inferred. For example, a small company like FFS may need only a few application packages to support most of the business processes.
- Platform Advisor determines the type of computing platforms needed by the company. Inferences are used heavily by this advisor. For example, desktops may be needed by the regular employees but powerful machines may be needed for CAD workers.
- Network Advisor helps in developing a network plan. This advisor infers different aspects of the communication network that interconnects various business units and the computing platforms. It then produces a detailed network configuration based on the information gathered. .

Each advisor produces a summary report that is stored in the KB. A consolidated report is produced at the end of PlanIT. Figure 1-25 shows a segment of the consolidated report for FFS.

Total Work Force	
Sites	2
Mangers	12
Knowledge Workers	24
Operators	12
Detailed Enterprise Model	Enterprise Model

Application Packages					
Automation Strategy for Business Processes					
Business Process	Buy	Build	Outsource	Reuse	Rent
Customer Support and CRM	X	-	-	-	-
Finance and Accounting		-	-	-	X
Human Resource Management		-	-	-	X
Wireless Messaging and Wireless web Management		-	X	-	-
Master Gantt Chart	View Detail				

Network Plan	
Total Co-operative Networks	2
Total External Networks	1
Total Networks Devices	10
Total Networks	12
Master Gantt Chart	View Details

Figure 1-25: Sample PlanIT Summary Report

1.6.2.2 SAM (Security and Administration Module) to Support PlanIT

SAM provides the following security and governance/administrative components to support PlanIT:

- Security Advisor secures the applications and the hosts on the network. It also produces a list that can be used in security audits.
- Project Planner develops a project plan based on the decisions made in the previous advisors.

- Governance Information Extractor examines the information from a diverse array of governance standards (e.g., CMM, CobIT, ITIL, SPICE, ISO200x, and SOX) and presents it to different advisors of the PISA platform as customized checklists.
- COTS (Commercial-off-the-Shelf) Advisor populates a Techbase that serves as a repository of commercially available solutions.
- Diagram Generator creates visual representations of the various solutions.
- Intelligent Document Generator produces reports at the end of the interview.

Figure 1-26 shows a sample security summary report produced by SAM for FFS. This report shows the key weaknesses for each object (e.g., a router, a server) and suggests security solutions for the weaknesses. More detailed reports provide risk analysis based on attack trees.

Security Recommendations		
Object Type	Weakness	Solutions
hub	Device is not placed in a secure Location	Protect the network device by placing in a controlled area
LANSwitch	Device is not placed in a secure Location	Protect the network device by placing in a controlled area
Router	Device is not placed in a secure Location	Protect the network device by placing in a controlled area
wired	Unauthorized access to root password/ID (can modify OS system and libraries)	keep root ID/PW under strong security
Custom Audit list		View Details
View Complete Detailed Report		

Figure 1-26: Sample Security Summary Report

1.6.2.3 AIM (Architecture and Integration Module) for SOA

PlanIT produces an enterprise-wide IT plan that shows the main elements of the IT infrastructure. However, it does not answer the important question: how will all these elements fit together to form a working solution? This is where AIM fits in. A user would typically develop an enterprise-wide plan by using PlanIT and then use AIM to investigate in more detail how different aspects of this plan can be integrated into an overall architecture. AIM helps its users to develop an integration plan based on Service Oriented Architecture (SOA) principles.

Development of an integration plan is a complicated task with many challenges. Instead of a ‘big bang’ approach where all enterprise systems are converted to SOA in an afternoon, AIM supports a gradual approach where the enterprise achieves an integrated architecture one business (application) area at a time. The AIM methodology, shown in Figure 1-27, guides the user through the iterative process of choosing a business problem and then developing and evaluating integrated architectures for the chosen problem. The AIM advisors perform the following activities (see Figure 1-27):

- **Integration Problem Explorer (IPE)** helps the user to select and define an integration project Pi in terms of participating applications. For large scale enterprise integration projects, the user goes through this process iteratively.
- **Integration Requirements Generator (IRG)** helps the user to quickly generate requirements documents that capture the essence of the integration problem for the selected business area.
- **Integrated Architecture Advisor (IAA)** guides the user through development of an integrated architecture, captures the problem complexity and translates the complexity into SOA features.
- **Integrated Solution Advisor (ISA)** guiding the user through the process of cost, performance and security estimates and producing ROI (return on investment) of the integration project.

These advisors support different stages of this methodology and generate extensive documentation (an integration requirements document, an integrated architecture document, and an evaluation report) that can be used to understand, explain and communicate the major decisions. The starting point for AIM is the overall IT plan generated by PlanIT.

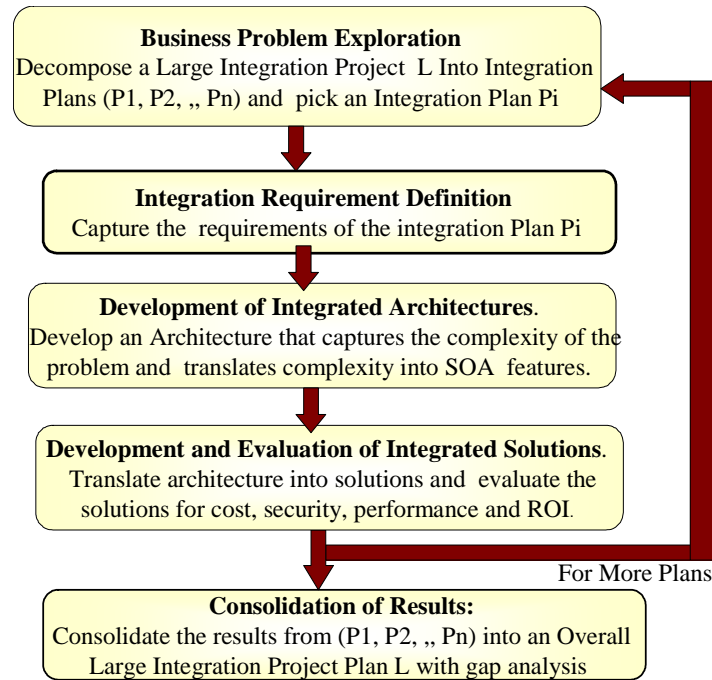


Figure 1-27: Conceptual View of AIM Methodology

AIM produces a large number of reports at its conclusion. The following figure displays the ROI (return on investment) calculations based on the integrated architecture proposed for FFS.

Expected Life of the System	5 years
Estimated time for integration	0.8 years
Estimated Integration Cost	\$106900
Current Operatins Cost	\$10000
Post Integration Projected Operations Cost	\$8000
Current Business Value	\$15000
Post Integration Projected Business Value	\$25000
Current Total Estimated Cost	\$10000
Post Integration Estimated Cost	\$114900
Current Total Estimated Benefits	\$25000
Current Total Estimated Benefits considering System changes	\$-35000
Post Integration Estimated Benefits	\$-31500
Post Integration Estimated Benefits considering system changes	\$-46500

Figure 1-28: Sample ROI Report Produced by AIM

1.6.2.4 Enterprises Composer: Building Larger and Complex Organizations

PISA was initially developed for small and medium (between 20 to 500 employee) organizations. However, PISA can be used to represent large and more complex organizations through its Enterprise Composer (EC) that takes different plans and composes them into larger and more complex organizational structures such as the following (see Figure 1-29):

- A large company consisting of many smaller plants, sites, and divisions..
- A large corporation based on mergers and acquisitions (M&A) of many companies
- A B2B marketplace with numerous buyers and sellers
- A supply chain system consisting of several consumers and suppliers
- A business network such as a health information network (HIN)

The Enterprise Composer treats each model generated by a PISA session as an organization unit (a reusable component) and composes large and complex organizations from these components by using SOA. It then suggests approximate configurations with details about the infrastructure components needed. The type of configurations and infrastructure components needed depend on the organizational composition and other parameters such as the number of participants (organization units), volume of transaction handled by the composition, value of transactions handled, security and trust level between the partners, etc. For example, the collaboration between partners in a supply chain require higher security than units of a large organization.

For FFS, a very interesting supply chain for furniture stores can be developed by using EC. For example, a team of analysts can develop a supply chain for furniture where each member of the team builds model of a store and then head of the team composes a supply chain from the individual models.

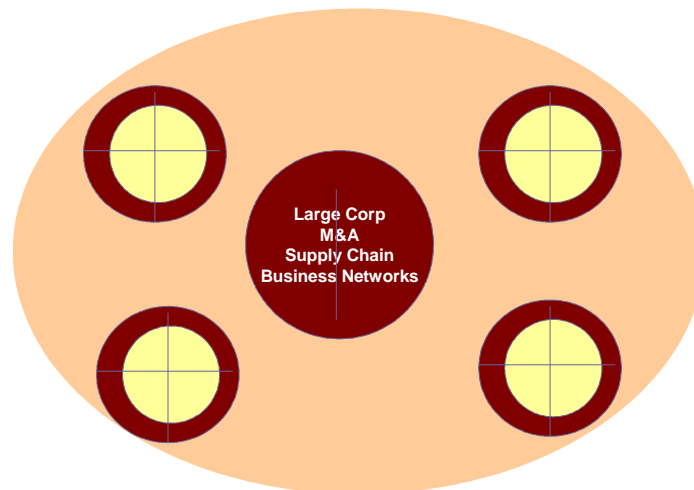


Figure 1-29: Building a Large PISA from Small Ones

1.6.2.5 Advanced Capabilities Module (ACM): Getting into More Details

The focus of the basic PISA modules (PlanIT, SAM and AIM) is to minimize user effort by extensively using defaults and patterns. Naturally this approach is not suitable for all situations. In many cases, more detailed analysis is needed, requiring more effort but providing more complete and accurate information. This is where ACM enters the picture – it accepts outputs generated by the basic PISA modules and shows how it can be used for detailed modeling and analysis. ACM expands the basic capabilities of PISA by:

- Allowing users to modify the output produced so far by using XML tools.
- Suggesting how users can do more detailed analysis by using existing modeling, simulation and analysis tools.
- Suggesting how users can develop their own tools by using outputs generated by the basic PISA system.

ACM is intended for more technically savvy people, especially knowledge of XML is required because all outputs produced by basic PISA are in XML. We are in the process of developing the following capabilities by using ACM:

- Advanced Business Process Analysis: business process modeling and workflow analysis
- Advanced Network Analysis: simulation analysis through tools such as Opnet
- Advanced Security Analysis: detailed attack tree and risk analysis
- Advanced SOA Analysis: detailed evaluation of SOA-based architectures

For FFS, an analyst can develop Flash demos of business process models and animations to better understand the workflows.

1.6.2.6 Technical Architecture of PISA

Figure 1-30 shows the technical architecture of PISA. The individual PISA advisors concentrate on different stages by using different artifacts, extensively use patterns for quick results, and enrich the knowledgebase as they proceed through the process so that other advisors can infer from this information. The collaboration between the advisors is supported through an inference engine and the knowledgebase. The controller provides the inference capabilities and supports multiple users with different know-how working on different business scenarios by using expert system, decision support, or development modes. The knowledgebase, as shown in Figure 1-30, contains a *pattern repository* that is populated with generic knowledge about enterprise solutions, and a *COTS (Commercial-Off-The-Shelf) database* that contains commercially available products. The PISA advisors read these two databases during their processing and use rules to produce company and scenario specific planning models that contain IT plans for different business scenarios. The initial planning model (*PM*) created is a simple sketch that is successively enriched as more advisors are invoked. The rich *PM* at the conclusion of an interview contains the complete IT plan and/or an enterprise architecture that is needed by a company.

It should be noted that PISA attempts to minimize the user effort to produce extensive documentation. In fact, the user inputs are optional in most cases because patterns provide reasonable defaults. Thus PISA can produce a quick sketch based on patterns and accumulated knowledge in *PM* without user interaction. This approach directly supports the business reality that some decisions need to be made quickly while others require detailed investigation and user inputs.

Figure 1-31 shows a more detailed view of PISA capabilities. In particular, this diagram shows the capabilities of the various advisors. Due to the heavy industrial and academic use, PISA capabilities are being expanded on an ongoing basis by NGE Solutions, Inc. For an up-to-date view of PISA, please visit the PISA website (www.ngepisa.com). In particular, please click on 'Learn More' button and then visit the 'PISA Documents' Section of the Website for more details.

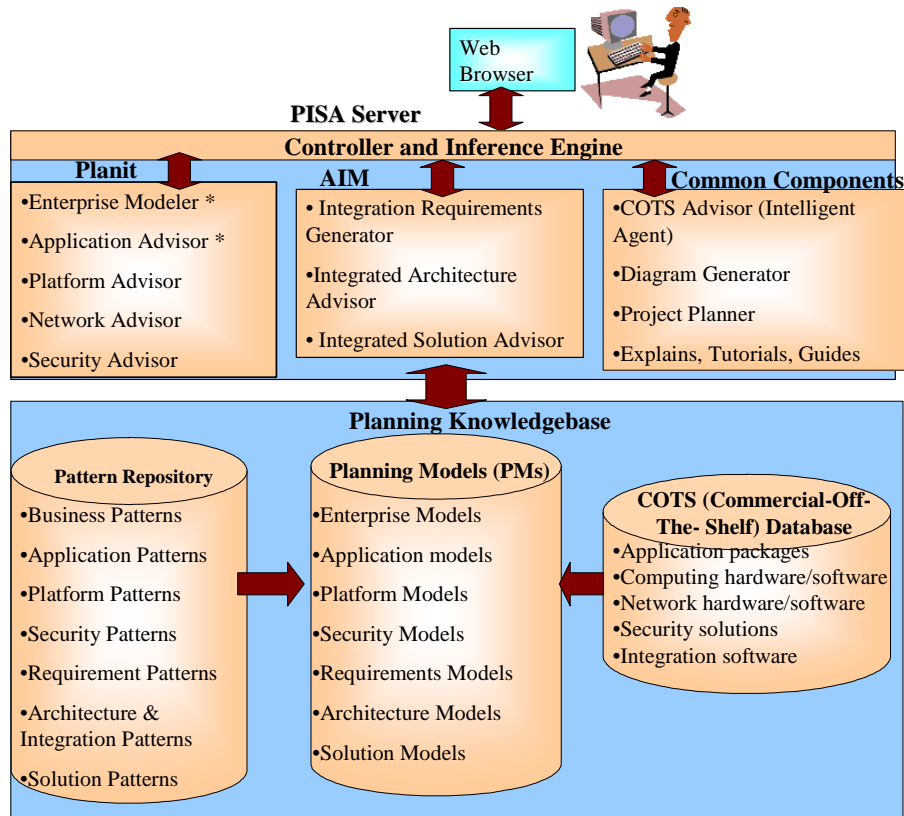


Figure 1-30: High Level Architectural View of PISA Environment

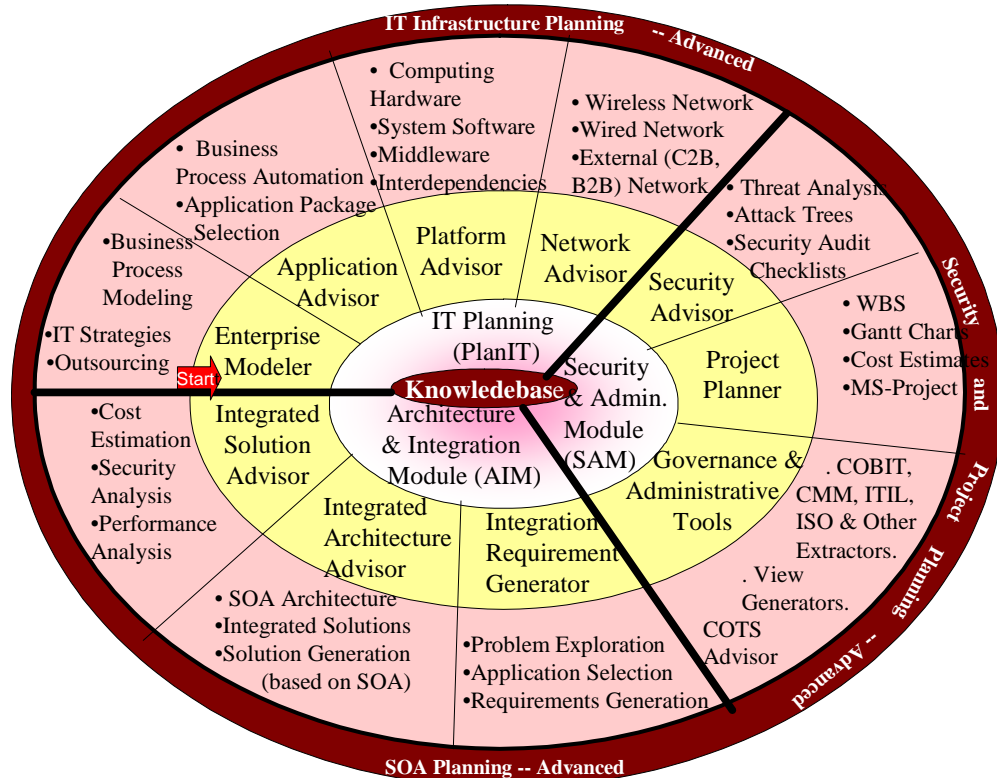


Figure 1-31: A More Detailed View of PISA Capabilities

1.7 The Book Roadmap

1.7.1 Book Outline

Enterprise systems, as indicated previously, are essentially large scale, in many cases global, distributed systems that consist of several broad building blocks (business architecture, application architecture that supports the business architecture, technology architecture that enables the applications, and integration architecture that all of the pieces work together. Figure 1-32 shows a Reference Model, based on Figure 1-7, that establishes the interrelationships between these building blocks and serves as a roadmap for this book (see the sidebar “Book Outline”). This book is organized in terms of the following modules:

- **Overview Module** (this chapter) paints the big picture of enterprise architectures and integration by using SOA as a conceptual framework. An overall methodology and a computer aided toolset is presented and illustrated through an example.
- **Enterprise Module** (chapters 2 to 4) concentrates on business and application architectures and covers topics such as business strategies, business process modeling, enterprise applications, ERP (enterprise resource planning) systems, and enterprise application integration.
- **Technologies Module** (chapters 5 to 8) primarily concentrates on the technical architectures that enable and support the business and application architectures. Main focus of this module is on the Web technologies with topics such as middleware services, the classical Web, XML, Semantic Web, Web 2.0, Web Services, e-Commerce platforms and transaction management.
- **Integration Module** (chapters 9 to 13) examines how to architect new and integrate existing applications by using SOA. This module covers a wide array of topics such as SOA, enterprise application integration through SOA, B2B trade and B2B integration using SOA, reengineering methodology for SOA and integration of mobile computing and mobile users using SOA.
- **Tutorials Module**, available from the author website (www.amjadumar.com), includes tutorials on basic technologies so that the book can be of value to novices as well as experienced practitioners.

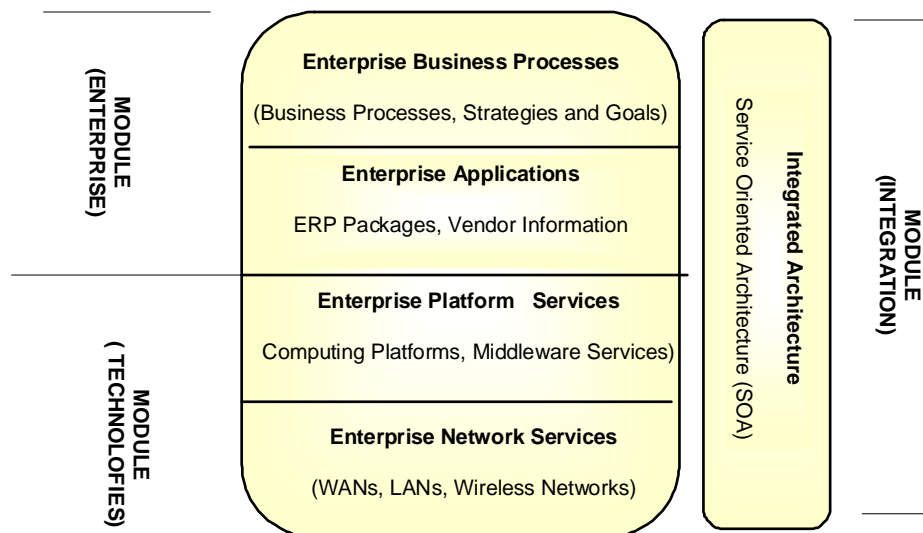


Figure 1-32: A Reference Model for Enterprise Architecture and Integration

<p>Book Outline</p> <p>Enterprise Architectures and Integration Using SOA <i>Concepts, Methodology and a Toolset</i></p> <p>Amjad Umar, Ph.D. (January 2010) (see www.amjadumar.com for details)</p> <p>MODULE (OVERVIEW): The Big Picture Chapter 1: Enterprise Architectures and Integration – The Big Picture</p> <p>MODULE (ENTERPRISE): Business Architectures and Application Architectures Chapter 2: Business Architectures: Business Strategies, Processes and Structures Chapter 3: Enterprise Applications and Enterprise Application Architecture Chapter 4: ERP Systems: Portals, CRMs, Procurement and Supply Chain Management Systems</p> <p>MODULE (TECHNOLOGIES): Technology Architectures Chapter 5: Overview of Enabling Technologies and Technology Architectures Chapter 6: Web, XML and Semantic Web Chapter 7: Web 2.0, Social Networks and Web Services Chapter 8: e-Commerce Platforms and Distributed Transaction Management</p> <p>MODULE (INTEGRATION): Integrated Architectures Through SOA Chapter 9: Service Oriented Architectures and Web Services Chapter 10: Enterprise Application Integration through SOA Chapter 11: B2B Trade and B2B Integration Using SOA Chapter 12: Reengineering for SOA: Reuse, Migration & Warehousing Strategies based on Cost, Performance & Security Chapter 13: Integration with Mobile Users – The Wireless Integration</p> <p>MODULE (TUTORIALS): Tutorials on Basic Technologies (available on author website) Chapter 1: Network Technologies -- A Tutorial Chapter 2: Object-Orientation, Java, and UML -- A Tutorial Chapter 3: Database Technologies and SQL -- A Tutorial</p>

1.7.2 How PISA Can be Used to Support this Book

This book is a result of consulting assignments, corporate training and graduate level courses taught at the University of Pennsylvania, Fordham Graduate School of Business and Harrisburg University. The courses have been taught by using 3 projects that involved manual as well PISA-based experiments. An overview of the projects is given in the sidebar “Suggested Projects”. Details can be found in the Instructor’s Guide for this book from the author site (www.amjadumar.com).

Suggested PISA Projects

Note: PISA is not a requirement for courses based on this book. However, PISA experiments greatly improve the learning process and generate extremely interesting discussions.

Project 1: Develop a Business, Application and Technical Architecture

- PART A: Develop an enterprise architecture for a small to medium business (SMB) by hand. Use the material in chapters 2-6 for the needed concepts and methodology.
- PART B: Develop the same architectures by using PISA-PlanIT. Specifically, produce a composite report by working with the following PISA advisors:
 - Enterprise Modeler to develop a business architecture
 - Application Advisor to develop an enterprise application architecture
 - Computing Platforms Advisor and Network Advisor to develop a technical architecture
- PART C: Do a critical analysis of the results (reports) generated by PISA-PlanIT and compare/contrast it with results produced manually. Improve the manual results by using the results produced by PISA-PlanIT and suggest improvements to PISA-PlanIT. .

Project 2: Develop an SOA-based Integrated Architecture

- PART A: Develop an SOA-based integrated architecture of the same SMB by hand. Use the material in chapters 9-12 for the needed concepts and methodology.
- PART B: Develop the same architectures by using PISA-AIM. Specifically, do the following by using PISA-AIM:
 - Explore the online purchasing system (also known as e-procurement) by using Business Problem Explorer
 - Develop a requirements document for online purchasing by working through the Intelligent Requirements Generator. Use different options in the interviews to develop an understanding of the system (interfacing applications, etc).
 - Develop an architecture document for online purchasing by working through the Intelligent Architecture Advisor. Run through various scenarios and options in the interview. For example, first assume that the purchasing app is hosted at MMS site (bypass ASP hosting) and then explore ASP hosting options.
 - Evaluate the selected architecture in terms of performance, cost, and security by using Integrated Solution Advisor.
- PART C: Do a critical analysis of the results (reports) generated by PISA-AIM and compare/contrast it with results produced manually. Improve the manual results by using the results produced by PISA-AIM and suggest improvements to PISA-AIM.

Project 3: Special Topics (Free for All)

Choose one of the following projects:

- Use PISA-ACM (Advanced Capabilities Module) to take results produced by PISA (in XML) to build Flash animations and/or connect to other tools such as BPEL for detailed analysis.
- Use PISA-EC (Enterprise Composer) to build different B2B integration scenarios by using SOA and experiment with them to understand the business as well as technology architecture issues.
- Compare-contrast PISA with other similar products by using hands on experiments.
- Other PISA or non-PISA oriented projects.

1.8 A Case Study: Introducing XYZCorp

We will use the following case study to illustrate the concepts introduced in this book. This case study is based on a realistic company. The actual names and places have been modified for business reasons.

XYZCorp was formed in 1985 by a small group of engineers in Chicago to build, repair, and sell electronic devices. The initial business of the company was televisions, radios and calculators. With time, the company included VCRs and PCs into its product lines. In the 1990s, the company entered into business partnerships with numerous suppliers around the globe and acquired a startup company that builds desktops, laptops, mobile devices, network devices (e.g., routers, switches), and cellular phones. XYZCorp also formed partnerships with numerous other computer hardware/software vendors and acquired several retail electronic stores that sell and service computers, televisions, VCRs, radios and other electronic devices. These stores also sell, market and service the XYZCorp products. In the 2000s, the company started thinking about providing technology solutions, consulting, and training services to a diverse array of industries. The company management believes in controlled growth, i.e., systematically explore new markets and diversify by using new products and services after careful strategic analysis and evaluation of core competencies.

The company headquarters are in Chicago with branch offices in the US, Europe and Asia. The company has currently about 3000 employees with a great deal of growth expected in the next 5 years. XYZCorp operates many regional offices: Southern (HQ: Atlanta), Western (HQ: San Francisco), Eastern (HQ: New York), Midwestern (HQ: Detroit), North Western (HQ: Seattle), European (HQ: Paris), and Asian (HQ: Tokyo). Each region supports between 5 to 10 local offices (some of these offices are stores, the others are marketing, training, consulting and support centers), with an average of 200 staff members per region.

To stay competitive and adapt to new products and services, the company has gone through several re-organizations and its IT infrastructure has changed several times. Most of the operations in the 1980s were manual -- a DEC computer in Chicago was enough to maintain the inventory, handle orders, and process accounts payables and receivables. In the early 1990s, an IBM mainframe with MVS operating system was installed and an IBM SNA (System Network Architecture) network was used to connect the various workers in the corporate office. The manufacturing plant adopted a Unix Sun platform. In the late 1990s, the company started using Web technologies and did some downsizing, but admittedly to stay fashionable (everyone around us is doing it, so we must too). In addition, thanks to the acquisitions and mergers, the company has accumulated layers of technologies and applications of different vintages that run on different computing platforms. Examples of some of the systems are:

- IBM mainframe-based administrative systems (payroll, accounts receivable, accounts payable)
- IBM DB2-relational database financial system

- An old Unix-indexed file system for customer support
- Many Unix-Oracle based regional systems
- Internet- based Human resource system and LANs
- Some ERP packages to support manufacturing and engineering systems on Unix based platforms
- Corporate network that consists of an Intranet that is connected to a public Internet through firewalls
- Several pilot projects on Web Services and Web 2.0.

Most of these systems do not work well together and this is a major deterrent to growth. Introduction of new systems to support new products takes months and responding to simple customer requests takes several weeks. The internal systems need to be overhauled and aligned to the corporate strategy but nobody knows what the corporate strategy is.

XYZCorp has hired a new CEO -- the good Ms Jones (BSCS, MBA). Ms Jones has promised to establish a clear business strategy that will position the company for success in the competitive marketplace. In particular, Ms Jones has promised that a business strategy will be established that will be implementable (i.e., it will be realistic enough so that it can actually work in the current business and technical environment). After a great deal of thinking, looking outside her window (jumping has been a possibility), making numerous phone calls ("Honey, I am going to be late again tonight"), and looking into literature (Want ads), she has decided to live up to her promise (a dangerous move!). She wants to explore the Next Generation Enterprise model with increased reliance on Web advertising, Web purchasing, virtual shops, customer relationship management, mobility and on-demand services for success (she does not know what she is getting into!). But seriously, she did form an enterprise-wide planning team. The team has identified the main tasks that establish an enterprise architecture and jtranslate business strategies to working solutions. These tasks, shown in Figure 1-33, are discussed as case studies in different chapters of this book.

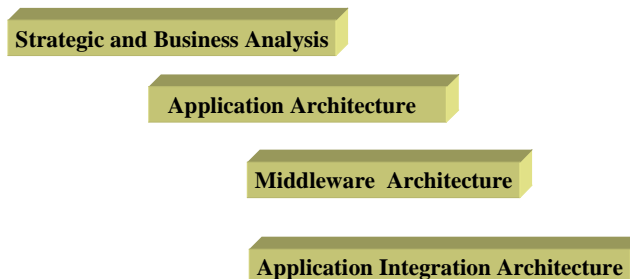


Figure 1-33: XYZCorp Planning Tasks

As we will see, each task will be further broken down into short projects in each module. This case study will help us to apply the techniques which we will learn in this book to a realistic enterprise. These tasks can be completed manually by using the guidelines suggested in this book. PISA can be used as a self assessment tool, i.e., to compare results based on paper and pencil efforts versus PISA and to understand and evaluate the differences.

1.9 Summary

Integrated enterprise architecture provides an inventory of the business and IT resources and how do they work with each other. Such an inventory promises many benefits that include: identifying what resources exist; improving integration among resources; facilitating business process improvement, and creating speed and efficiency in meeting changing business needs through IT. These benefits directly impact the overall organizational performance and competitive advantage. However, it is not clear how exactly to develop such architectures.

In this chapter, we have given an overview of enterprise architectures and integration and have discussed how SOA can be used in developing an integrated enterprise architecture (IEA). We have also proposed a systematic methodology that can be used to develop IEAs. In addition, a comprehensive toolset, called PISA (Planning, Integration, Security and Administration) has been presented to develop IEAs for practical situations. PISA can also be used as a teaching tool for this book. We have introduced a case study (XYZCorp) that will be used throughout this book to show how the knowledge gained can be used to address practical problems.

1.10 Review Questions and Exercises

- 1) Scan the literature and find at least three definitions of an enterprise architecture
- 2) Scan the literature and discuss three examples of companies that have used innovative approaches for enterprise architectures. Also find at least one company that has failed in this area.
- 3) List the main benefits, in order of priority, and risks of an EA.
- 4) What is difference between EA and IEA. Explain through an example.
- 5) Scan the literature for enterprise integration projects and categorize the examples as vertical, horizontal or mixture integration efforts. ;
- 6) In your view, what is the main strength of SOA to deliver business value? What is the main weakness (risk)? Give three specific examples to illustrate the use of SOA in enterprise architecture and integration. .
- 7) Visit the SOA sites at IBM and other SOA players and create a list of resources available from such sites.
- 8) Compare and contrast PISA with at least two industrial products. You should visit the PISA Website (ngepisa.com) to familiarize yourself with the PISA toolset first.
- 9) Suppose that you have been asked to develop a two day management training program in enterprise architecture and integration.. What topics will you cover in this program and what automated tools, besides PISA, will you use ?
- 10) Access some websites such as emarketer.com, fedex.com and others to find the latest statistics on ebusiness growth and decline and some innovative IS projects in the field.

- 11) Access Startupfailures.com and identify the main causes and lessons learnt from dotcom failures.

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